REVISION 3

NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 505
PIPING SYSTEMS

THIS CHAPTER SUPERSEDES CHAPTER 505 REVISION 02 DATED 1 DECEMBER 2001

PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND.

1 DEC 2006

REVISION RECORD

REVISION NO.	DATE	TITLE AND/OR BRIEF DESCRIPTION/PREPARING ACTIVITY
3	1 DEC 2006	PARAGRAPH(S) 505-1.1, 505-9.17.5.2, 505-11.1.2.6 AND 505-11.1.2.7 TABLE(S) 505-6-5., 505-7-1., 505-11-2. AND 505-12-2.
TMDERS/ACNS INCORPORATED:		
ACN 1/A ACN 2/A	5 MAR 2003 15 AUG 2003	CORRECTING VALVE HABDWHEEL TORQUE VALUES CLARIFICATION OF HYDROSTATIC TEST REQUIREMENTS

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

Chapter/Paragraph Page

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

Chapter/Paragraph Page

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

Chapter/Paragraph Page

TABLE OF CONTENTS - Continued

Chapter/Paragraph Page

TABLE OF CONTENTS - Continued

Chapter/Paragraph Page

TABLE OF CONTENTS - Continued

Chapter/Paragraph Page

TABLE OF CONTENTS - Continued

LIST OF TABLES

LIST OF TABLES - Continued

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS - Continued

LIST OF ILLUSTRATIONS - Continued

CHAPTER 505

PIPING SYSTEMS

SECTION 1
GENERAL CONSIDERATIONS

505-1.1 DEFINITIONS

1. Cutout or Isolation Valve. A valve that is intended to be either fully open or fully closed.
2. Expansion Joint. A flexible rubber or metal pipe coupling used to take up axial and lateral pipe movements due to thermal movement of a piping system.
3. Feedwater. Water that meets requirements for boiler makeup feedwater.
4. Fitting. A part of a piping system used to join sections of pipe or tube, such as couplings, unions, elbows, reducers, bushings, tees, laterals, bosses, crosses, etc. Also included are caps, plugs, flanges, > and mechanically attached fittings (MAFs).
5. Flammable and Combustible Materials. All liquids, solids, and gases having a flash point below 200°F and fluid that can be ignited by application of flame or otherwise ignited under atmospheric conditions. This includes lube oils and hydraulic oils similar to MIL-L-17331 and MIL-H-17672, coolants and aerosols. See **NSTM Chapter 670, Stowage, Handling, and Disposal of Hazardous General Use Consumables.**
   a. Category I Flammables and Combustibles: Materials having flash point below 200°F. Category I flammables and combustibles are referred to as flammables.
   b. Category II Combustibles: Materials with flash points at or above 200°F
6. Flexible Hose. A flexible tubular shape identified by inside diameter, service, and pressure class.
7. Fresh Water. A term that refers to potable water.
8. Fresh Water Drains. A term that refers to drains from service steam systems and drains from higher pressure steam systems. These drains are of feedwater quality and are returned to the condensate system.
9. Fuel. Unless otherwise specified, fuel referred to in this section means MIL-F-16884, **Fuel, Naval Distillate** , F-76 or MIL-T-5624, **Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP-5/JP-8 ST.**
10. Hydrostatic Test. A test where the piping system or a portion of the system is pressurized above maximum operating pressure to a specified hydrostatic test pressure and inspected for leakage and visible deformation. The purpose of a ″hydrostatic test″ is to test for strength and porosity, as opposed to an ″operating pressure test″ for mechanical joint leakage.
11. Major Repair. Any work/rework where the pressure-retaining boundary of pipe or piping components is affected by welding, brazing or other fabrication processes which could affect the structural adequacy of the material or component.

NOTE

Component renewal (including pressure boundary piece parts and/or assemblies) is a major repair unless the component has been hydrostatically tested prior to installation into the assembly or system. Replacement of the following items is not considered a major repair: valve packing, pump packing, pump mechanical shaft seals, seals (gasket and o-rings), mechanical joint bolting (bolts, studs, washers, locking devices and nuts), and stems.

12. Maximum Operating Pressure. The highest pressure that can exist in a system or subsystem under normal operating conditions. This pressure is determined by such influences as pump or compressor shutoff pressures, pressure regulating valve lockup (no-flow) pressure, and maximum chosen pressure at the system source.

13. Maximum System Temperature. The highest temperature that can exist in a system or subsystem during any operating condition.

14. Maximum System Pressure. The highest pressure that can exist in a system or subsystem during any condition exclusive of water or steam hammer. The nominal setting of the relief valve (see paragraph 505-9.18, which covers relief valve setting and installation) is the maximum system pressure in any system or subsystem with relief valve protection. Relief valve accumulation may be ignored.

15. Minimum Operating Pressure. The lowest pressure that can exist in a system or subsystem under normal operating conditions. This pressure is usually determined by such influences as the minimum allowable oil supply pressure to a bearing or situations where corrective action shall be taken when pressure drops below a safe minimum pressure rather than exceeding a maximum pressure.

16. Minimum Operating Temperature. The lowest temperature that can exist in a system or subsystem under normal operating conditions. This temperature is determined by such influences as the lowest temperature at which a system or component can operate without causing a system malfunction. It is used where corrective action is more appropriately taken at a low-temperature limit rather than a high-temperature limit.

17. Minor Repair. Any repair/rework where the pressure-retaining boundary of pipe or piping components is not affected by welding, brazing or other fabrication processes, which could affect the structural adequacy of the material or component.

NOTE

Reassembled mechanical joints, replacement of gaskets and seals, weld repair of the surface seating area of mechanical joint flanges, and epoxy repairs in accordance with approved procedures are all considered minor repairs.

18. Nominal Operating Pressure. The approximate pressure at which an essentially constant pressure system operates when performing its normal function. This pressure is used for the system basic pressure identification.

19. Nominal Operating Temperature. The approximate temperature at which an essentially constant temperature system operates when performing its normal function. This temperature is used for the system basic temperature identification.

20. Operating Pressure Test. A test where the system or a portion of the system is filled with its normal fluid medium, pressurized to nominal operating pressure, and inspected for joint leakage.

21. Pipe. Tubular shape identified by nominal pipe size and schedule or wall thickness.

22. Piping. An assembly of pipe or tube, including fittings and inline components normally supported with the piping such as valves and strainers, that is necessary to form a part or the whole of a system used for conveying fluids, exclusive of major equipment or components.

23. Piping System. The piping, pumps, heat exchangers, compressors, and other fluid-containing items necessary to perform a specified operation or control function.

24. Potable Water. Water that meets requirements for drinking water.

25. System Design Pressure. The pressure used in calculating minimum wall thicknesses of piping and piping components. The system design pressure shall not be less than the maximum system pressure.

26. System Design Temperature. The temperature for which all equipment shall be designed in the system or subsystem. Unless otherwise specified, the design temperature shall equal or exceed the maximum system temperature.

27. Tube or Tubing. Tubular shape identified by outside diameter and wall thickness or pressure class in the case of CuNi.

505-1.2 PIPING SYSTEM SAFETY PRECAUTIONS

WARNING

Whenever work on hazardous systems such as fuel, high pressure steam, high pressure air or oxygen is accomplished, replaced parts must conform to the equipment drawing/repair standards. Where Navy owned production drawings are available as in the case of the FSFO strainer, material substitutions should not be made. In emergency situations, substitutions must be approved by the Engineering Officer or NAVSEA. The Engineering Officer shall oversee all repairs especially on hazardous systems/components and approve any material substitutions. Maintenance personnel should be made aware of hazards when repairing systems or components so they appreciate the safety risk associated with improper assembly or part substitution failure.

WARNING

When parts are duplicated by a ship, or IMA, appropriate drawings should be used instead of using the old part to obtain dimensional or materials information. When a request to make a part is made, the system and component should be identified. Where it is in a hazardous system, precautions should be taken to assure dimensions, materials and finishes are in accordance with Navy drawings. Whenever equipment is repaired, shipboard operational pressure tests should be accomplished. These tests should be accomplished in a controlled manner by bringing the pressure up slowly with personnel safely stationed to quickly secure the pressure source in the event of failure.

505-1.2.1 GENERAL SAFETY PRECAUTIONS. Personnel shall comply with the following general safety precautions in addition to those of the ship:

1. Forces afloat comply with Navy Safety Precautions for Forces Afloat, OPNAVINST 5100 series.

2. Exercise extreme caution in vicinity of operating equipment. Keep hands, tools, and loose clothing clear.
3. Comply with ship and shore regulations for working aloft.
4. Appropriate personnel protective equipment identified in OPNAV P 45-110-91 (0420-LP-181-6600), **Hazardous Materials Users Guide** , shall be used when contact with hydraulic fluid or lubricating oil is probable. In atmospheres containing a fine mist of these fluids, a full facepiece protective mask and continuous air line respirator must be worn. When in doubt, use a tank sniffer per NSTM Chapter 074, Volume 3, **Gas Free Engineering** , to test the air near any open paths to suspect fluids, such as at hydraulic reservoir fill ports, during maximum pressure and flow to determine whether fine mists are being formed. Misting is excessive when it violates the airborne limits of individual material safety data sheets (MSDS's), or the 0.005 milligrams per liter limit stated in NSTM Chapter 074, Volume3. See NSTM Chapter 556, **Hydraulic Equipment Power Transmission and Control** , for instructions on the proper handling of hydraulic fluids.
5. Ensure all tag-out procedures are in accordance with NAVSEA S0400-AD-URM-010/TUM, **TAGOUT USERS MANUAL** .
6. Lagging and insulation must be clearly identified as asbestos or non-asbestos (non-asbestos material can be identified with red color or ship documentation) prior to cutting, dismantling or removal. Until lab analysis results are available all suspect asbestos containing material (ACM) will be considered to be asbestos. If ACM was identified, contact asbestos removal team to accomplish lagging/insulation removal per **NSTM CHAPTER 635 THERMAL, FIRE, AND ACOUSTIC INSULATION .**
7. Avoid any method which may cause asbestos dust to become airborne.
8. Exercise caution when working on piping systems of which any portion is pressurized (see section 8).
9. Exercise extreme caution when working on a valve or strainer whenever the system is pressurized.

505-1.2.1.1 There have been several casualties where the stems or shafts of valves or strainers have been ejected. The stem or shaft can become a lethal projectile, and the system working fluid can burst forth from the valve or strainer with catastrophic results. Whenever these or any other piping system components are being worked on, there is a potential hazard. The specific cause of the hazard lies in the action of the system working-pressure pushing up on the stem or shaft, trying to push it out of the valve or strainer. The actual force trying to push the stem or shaft out can be calculated as:

EJECTION FORCE = SYSTEM PRESSURE x SHAFT CROSS-SECTIONAL AREA

For a shaft having a 1-1/4 inch diameter in a valve with a system pressure of 250 psi:

EJECTION FORCE = 250 lb/sq in. x 1.23 sq in. = 308 lb

A relatively small-looking shaft can have a tremendous force behind it.

505-1.2.1.2 Stems and shafts are ejected whenever the system pressure is present while working on the valve or strainer; and the collars, pins, or other fasteners used to hold the stem or shaft into the body of the valve or strainer have failed, have not been properly replaced, or have worked loose and fallen out. For example, some butterfly valve stems and fuel strainer shafts are retained by a spring pin through the stem or shaft. Either of these can be easily removed by unsuspecting maintenance personnel. Unauthorized substitutions of pins or other fasteners must not be made. If work schedules or lack of approved pins prevent replacement, substitutions must be cleared by the engineering officer or the Naval Sea Systems Command (NAVSEA) life-cycle manager (LCM). Also, unauthorized substitutions for pins can result in a pin being eaten away by the corrosive effects of seawater or fuel. Furthermore, many times these same pins work loose due to machinery vibrations and internal working fluid turbulence and fall to the bottom of the valve or strainer body.

505-1.2.1.3 Often a greater hazard may exist simply by removing a valve actuator whenever the system is pressurized. Some valve designs use the actuator fasteners to retain the valve stem or shaft. Unsuspecting maintenance personnel could be seriously injured simply by removing the actuator bolts.

505-1.2.1.4 Therefore, to avoid any casualty, when beginning work on system components such as valves and strainers, depressurize the system. If it is impossible to depressurize the entire system, try isolating the component using other system valves, and depressurize just the portion of the piping where the valve or strainer is located.

505-1.3 RELATIONSHIP TO OTHER GUIDANCE DOCUMENTS.

NSTM Chapter 505 is intended to be a standard so that appropriate sections of other guidance documents can refer to it. As an example, Section 11 is intended to be the focal point for testing requirements. When conflicts are found in the testing requirements, NAVSEA (A05L and 92T) should be notified for resolution

505-1.4 INSPECTIONS

505-1.4.1 GENERAL. Early detection and correction of piping system problems are of utmost importance. Personnel safety and the operational reliability of ships requires that all piping systems be in proper operating condition. Inspections shall be conducted in accordance with Planned Maintenance System (PMS) requirements where PMS is installed.

CAUTION

Ensure proper fasteners are used in accordance with NSTM Chapter 075, Threaded Fasteners.

505-1.4.2 LEAK INSPECTIONS. Inspect piping systems for leaks. Locate and repair any leaks found.

505-1.4.2.1 Compressed Gas Systems. In systems containing compressible fluids, such as high- and low-pressure air and steam, leaks may be indicated by an audible hissing noise and/or a decrease in system pressure.

WARNING

Exercise extreme caution when working on systems containing high-pressure or high-temperature fluids. Severe injury can result from contact with these fluids.

505-1.4.2.1.1 Leak Location. Leaks may be located by applying leak detection solution per MIL-L-25567, **Leak Detection Compound, Oxygen Systems** , over suspected areas. Leaks will be indicated by the formation of bubbles. An alternate method of detecting leaks is to use an ultrasonic detector, either one from UE Systems, Inc., West Main St., Elmsford, NY 10523, 800-223-1325 or Windustrial Co., 3251-B Old Frankstown Road, Pittsburgh, PA 15239, 412-327-8600, NSN 6635-01-156-3927. An additional detector is the Model SDT 850-150 Ultrasonic Detector Kit from SDT USA, P.O. Box 12098, Santa Rosa, California 95406-2098, 707-577-8053.

CAUTION

Before removing lagging, ensure it does not contain asbestos. Asbestos Containing Material shall be controlled per NSTM CHAPTER 635, THERMAL, FIRE, AND ACOUSTIC INSULATION.

505-1.4.2.1.2 Lagged/Insulated Piping Systems. In lagged/insulated piping systems, leaks are indicated by wet or stained lagging/insulation. Remove wet or stained lagging/insulation. Locate and repair any leaks or other sources of wetting (e.g. overflowing funnels). If no leaks are found, visually inspect for external corrosion in accordance with section 505-1.4.3. Where there is clear evidence of significant external corrosion, UT readings may be taken in the affected area in accordance with section 505-1.4.4. Renew the lagging/insulation. Remove lagging/insulation from areas where leaks are suspected if the contour of the lagging/insulation indicates the presence of a pipe fitting or piping component. Limit the extent of removal to that necessary to accomplish the inspection and repair. In that case, renew with removable lagging/insulation.

NOTE

The cause of wet and stained lagging may not be leakage from the piping system on which the lagging is installed. Neighboring piping systems or components may be leaking onto the lagging.

505-1.4.2.2 Systems Having Spray Shields. Inspect spray shields for signs of joint leakage.

CAUTION

Before removing lagging, ensure it does not contain asbestos.

505-1.4.3 EXTERNAL INSPECTION. Where PMS has been implemented, conduct planned maintenance according to MRCs. The following inspection requirements can be used where PMS has not been implemented. Inspect piping for external corrosion every six months or at first availability. Special attention shall be given to piping that is located in high moisture and isolated spaces, and to piping made from ferrous materials. Only wet or stained lagging needs to be removed for this inspection.

505-1.4.3.1 Pitting and Rust. Visually inspect piping in bilge areas for external corrosion. Where tightly adhering thin rust is found, clean the affected surfaces according to paragraph 505-7.7.7. Where pitting or loose flaking rust is found, clean the affected surfaces and measure wall thickness by ultrasonic inspection in accordance with NAVSEA T9074-AS-GIB-10/271, **Requirements for Nondestructive Testing Methods** and paragraph 505-1.4.4. Ultrasonic thickness measurements do not account for pit depth on the external surface. Pit depth must be measured directly then subtracted from the ultrasonically measured value to determine actual wall thickness.

CAUTION

Before removing lagging, ensure it does not contain asbestos.

505-1.4.3.2 Wetness or Stain. Inspect lagged piping in bilge areas for wet or stained insulation. Remove wet or stained lagging and inspect the exterior condition of the piping. Locate and repair any leaks found. Renew the lagging in accordance with applicable specifications.

505-1.4.3.3 Carbon Steel Fuel and Lube Oil Piping. This inspection is to be performed on all carbon steel piping not located in tanks that carry fuel or lube oil. Such piping includes fill and transfer systems, service systems, stripping systems, and air escape (vent) tank overflow and sounding tube piping. The inspection should be accomplished when the ship is in port in a cold iron condition. The inspection should coincide with other system inspections.

505-1.4.3.3.1 General. Carbon steel fuel and lube oil piping experiences external corrosion, especially in bilge areas. Fuel piping located with steam piping in the aircraft carrier steam catapult piping trunk and voids also experiences external corrosion. In some ships this fuel piping is lagged. The inspection procedures for lagged piping apply, in accordance with paragraph 1.4.3.2. The corrosion sometimes causes extreme wall thinning in isolated and unpredictable locations. This inspection method coordinates visual testing, hammer testing, and ultrasonic testing to locate and evaluate isolated thin spots. Some thin spots may not be found before they develop into leaks, especially thin spots caused by pitting corrosion. System operators should always watch for evidence of leakage. To replace existing carbon steel piping with copper-nickel and stainless steel piping, see paragraph 505-1.4.3.4.

505-1.4.3.3.2 Preparation for Inspection. Ensure all systems to be inspected are secured. Ensure the bilge is pumped down, so all piping is visible and accessible. Gather the following required materials:

1. Flashlight
2. Mirror
3. Pen and paper
4. Ball-peen hammer
5. Rag
6. Chalk
7. Temporary pipe repair kit
8. Fire extinguisher.

505-1.4.3.3.3 Visual Inspection. Inspect the entire surface of the piping, except for lagged piping. Use the flashlight and mirror to inspect areas that cannot be seen directly.

a. Look for the following problems:
   1. Leaks. Look for holes in the piping or fuel dripping from the piping. Look for areas where the piping appears wet. Try to dry wet areas with a rag. If the wet spot returns and smells like fuel, there is a leak in the pipe.

2. Thin spots. Look for areas where the pipe surface slopes inward toward a thin spot. Their appearance is like that of a dented or dished-in area on the pipe surface. Thin spots usually occur in areas of severe surface corrosion. If metal is flaking off the pipe, dislodge the flakes before evaluating the surface.
3. Excessive surface corrosion. Look for tightly adhering thin rust, flaking metal, and pitting.

b. Circle all potential problem areas on the piping surface with chalk and note their locations on the paper. Be generous with the selection of potential problem areas. Circle the following areas:
   1. All leaks
   2. All dished-in areas
   3. The thinnest-looking place in all areas of metal flaking
   4. The thinnest-looking place in all areas of heavy Corrosion
   5. Any other area that seems thin to the inspector.

WARNING

Hammer testing should only be performed on a secured system. In some cases, the hammer passes through the pipe wall, causing a major fuel leak.

CAUTION

Use a ball-peen hammer for hammer testing. Sharp hammers intended for chipping can dent the pipe and damage the paint, increasing the pipe corrosion rate.

505-1.4.3.3.4 Hammer Testing. All potential problem areas should be hammer-tested with the ball-peen hammer. A good section of pipe will produce a sharp ringing sound when struck. A dangerously thin pipe wall will dent easily or produce a dull thud when struck. It is not necessary to test the pipe wall at leaks, since leaking pipe clearly must be replaced. If the hammer passes through the pipe wall, that section of pipe must be replaced. Otherwise, ultrasonic inspection will be required to evaluate the wall, regardless of the sound the wall makes when struck. A sharp ringing sound from the wall does not guarantee that the wall thickness is adequate. If the wall makes a dull thud when struck, as if the hammer were striking soft material, there is probably excessive corrosion in the wall. Be careful to remove all of this excessive corrosion when preparing the wall for ultrasonic inspection.

NOTE

Hammer testing can only verify that a pipe wall is NOT good; it cannot establish that a wall is good.

505-1.4.3.3.5 Ultrasonic Inspection. Measure the wall thickness by ultrasonic inspection at circled areas that are not leaking. Prepare the surface according to paragraph 505-1.4.4.3.1 and conduct the inspection according to paragraph 505-1.4.4.3. Measure the wall thickness only at the circled areas. The inspection technique described in paragraph 505-1.4.4.3.1, and typically performed every 3 or 4 feet axially, is unnecessary. Fleet experience has shown that the inspection approach rarely finds thin spots in carbon steel fuel piping because the thin spots are so small and isolated. Ultrasonic thickness measurements do not account for pit depth on the external surface. If the surface is pitted, pit depth must be measured directly then subtracted from the ultrasonically measured value to determine actual wall thickness. Evaluate measured wall thicknesses according to paragraph 505-1.5.1.

505-1.4.3.3.6 Actions Required After Inspections. Replace piping that is leaking or that has unacceptably thin walls at the first opportunity. If leaking piping cannot be replaced immediately, it can be temporarily repaired in accordance with paragraph 505-8.6. Systems containing piping with unacceptably thin walls or temporary repairs shall be operated with special attention. Record locations and wall thicknesses of all thin spots found, even if the thin spots were not below the minimum criterion. The list of thin spots will help locate potential problem areas in future inspections. Clean and repaint all corroded areas that are not going to be replaced according to paragraph 505-7.7.7. Also clean and repaint all areas that were prepared for ultrasonic inspection and are not going to be replaced.

505-1.4.3.4 Copper-Nickel and Stainless Steel Fuel Piping. Copper-nickel or stainless steel piping may be installed in existing steel fuel systems if the following conditions are met:

1. The new material will run only between tanks or existing flanges that are high enough to avoid bilge water. No material transitions shall be located in the bilge.
2. All components in the new line will be replaced with galvanically compatible components to prevent rapid galvanic corrosion of steel components.

505-1.4.3.4.1 Stainless steel does not resist corrosion by seawater as well as copper-nickel. Consequently, stainless steel fuel piping is not used in bilge areas of steam ships or in tanks that may contain seawater. Copper-nickel has been used in some ships to replace piping in the bilge area or in tanks that may contain seawater, since it is more resistant to corrosion.

505-1.4.3.4.2 Installing short pieces of copper-nickel or stainless steel in a carbon steel piping system in the bilge can lead to severe galvanic corrosion. The remaining carbon steel will corrode sacrificially, protecting the new material. The corrosion of the steel may not occur next to the new material but instead could occur anywhere the paint on the steel has broken down.

505-1.4.3.4.3 Copper-nickel or stainless steel fuel piping in immersion areas such as bilges shall be kept painted to reduce galvanic corrosion of nearby steel and to prevent corrosion of the stainless steel. Immersion areas are where the piping is at least occasionally immersed. Dry bilges are not immersion areas. Refer to NSTM Chapter 631, Volume I, **Preservation of Ships In Service - General** , for detailed painting requirements.

505-1.4.4 WALL THICKNESS INSPECTION. Wall thickness can be reduced by the combined effects of erosion and corrosion. Wall thickness measurements are made by ultrasonic inspection (UT).

a. UT inspections are required where pipe thickness measurements are specified on PMS/MRC cards.
b. For main engine room and propulsion piping, UT inspections are recommend for systems that have a high probability of deterioration from corrosion or erosion. These systems are:
    (1) Boiler blow piping.
    (2) Fuel systems using ferrous materials, primarily in bilge area where external corrosion is apparent. See paragraph 505-1.4.3.3.3.

(3) Steam drain systems primarily in H.P. drain piping. However, if a high chloride problem occurred or system is or has been laid up for extended time, then steam source system should also be checked.

(4) Main and auxiliary sea water (S.W.) cooling and SW. firemain systems having fluid normally flowing above the maximum velocity shown in table 505-5-1.

505-1.4.4.1 Inspection Frequency. Refer to applicable PMS documents for specific wall thickness inspections. Specific locations in a selected system are to be in accordance with paragraph 505-1.4.4.2.

a. System Inspection Programs. Some systems such as boiler blow, soot blower and boiler HP drain systems have extensive and frequent inspection requirements and reporting requirements due to a long history of short life for the piping. See applicable PMS documents and paragraph 505-1.5.

b. Piping System Surveillance Program. A piping system surveillance program using PMS (e.g. MRC cards) is recommended based on an engineering evaluation for systems which experience pipe wall degradation due to adverse external or internal environment or operating conditions. The surveillance program is highly recommended for critical systems in which a failure could present a safety hazard or degrade the operational capability of the ship. Areas of piping that should be considered for inclusion in a surveillance plan are:
   1. Carbon steel piping located in bilge areas.
   2. Carbon steel steam drain piping in saturated steam systems.
   3. CuNi seawater piping subjected to turbulent flow (severe pipe bends, piping downstream of reducing stations and reducing fittings, etc.). A ″severe pipe bend″ is intended to mean a pipe bend with a bend radius less than five diameters.
   4. Non copper-nickel piping in seawater or AFFF systems such as aluminum washdown countermeasure system or galvanized dry sprinkling.
   5. Other piping systems, such as sewage piping, where the operating fluid is highly corrosive or erosive, and areas that are known problems.

505-1.4.4.1.1 Inspection Program Purpose. The purpose of the surveillance program is to monitor the material condition of the piping system and shall consist of visual inspections and if required, ultrasonic tests. Ultrasonic inspections are only recommended where visual inspection cannot adequately ascertain pipe condition (internal degradation). Piping system inspections shall be accomplished in accordance with the applicable requirements of section 505-1.4.

505-1.4.4.2 Inspection Locations. As a minimum, wall thicknesses shall be measured in the following locations:

1. Adjacent to all welds
2. All elbows and bends (special attention shall be given to the outside radius)
3. Low points
4. Locations where thinning is suspected.

505-1.4.4.3 Ultrasonic Measurement. Wall thickness shall be measured ultrasonically in accordance with NAVSEA T9074-AS-GIB-010/271.

505-1.4.4.3.1 Inspection Technique. As required, remove hangers, clamps, and guards at bulkheads and casing penetrations to gain access to corrosion-prone areas of pipe. Prepare the pipe or tube to be inspected by removing all rust, rust scale, and corrosion products to produce a clean, moderately bright surface. Record the results of four measurements taken at 90-degree intervals around the circumference. Where four static readings cannot be obtained, the continuous scanning method (single pass) may be used provided it is applied to a minimum 180-degree segment of the pipe's outer surface.

505-1.4.5 DRAINS. Inspect and clear drains at least once every six months to prevent clogging.

505-1.4.6 SCREENS. Inspect and clean quarterly screens installed at the end of tank vent and air escape lines to prevent tank overpressurization due to clogging.

505-1.4.7 INSPECTION OF COPPER PIPE AND BRONZE FITTINGS. Inspect service steam and service steam drain systems constructed of brazed copper piping and bronze fittings for bulging adjacent to brazed joints where hard drawn copper piping became annealed during the brazing process. When such bulges are found, take the following actions for each bulged section:

a. Determine, by measurement, the outside diameter of the bulged section (Db) and the original nominal outside diameter (Do). The Do may be determined from the system drawing and the material specification referenced on the drawing, such as MIL-T-24107, **Tube, Copper (Seamless) (Copper Alloy Numbers C10100, C10200, C10300, C10800, C12000, C12200, and C14200).**

b. Determine the percent of bulging as follows:

   [(Db-Do)/Do]x100=% of bulging

   For example:

   Measured diameter Db = 4.885 inches

   Original diameter Do = 4.500 inches

   Percent of bulging = [(4.885 - 4.500)/4.500]x100 = 8.56%

c. If the pipe bulge is less than 5 percent, that section of piping does not have to be replaced and may be returned to service. Temperatures and pressures are not to exceed those for which the system was designed. Reinspect the pipe bulge again within 12 months. It is recommended that removable insulation be installed where future inspections are required.

d. If the pipe bulge is greater than 5 percent but less than 10 percent, calculate the hoop stress in the bulged piping as follows:

   S = PDb/2t - 0.4P

   where:

P	system design pressure, lb/in.^{2}
t	measured wall thickness of the bulge section, inches
Db	outside diameter of bulge
S	stress

e. The calculated stress shall not exceed the allowable stress values listed in table 505-1-3 for the applicable material. Stress values for annealed material shall be used where a choice is given. If the calculated stress exceeds the allowable stress indicated, replace the piping section. If the calculated stress is less than that allowed, reinspect the pipe bulge again within 12 months.

f. If the pipe bulge is 10 percent or greater, replace the piping section. Replacement piping shall be per ship drawings; MIL-STD-777, **Schedule of Piping, Valves, Fittings and Associated Piping Components for Naval Surface Ships** ; or MIL-STD-438, **Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarine Service** . Applicable Project Peculiar Document (PPD) may be used as an option to MIL-STD-438 and MIL-STD-777.

505-1.4.8 INSPECTION OF BOILER BLOW PIPING. Inspection of boiler blow piping shall include all piping downstream of the individual boiler blowdown valves. Refer to NSTM Chapter 221, **Boilers** , for inspection of pressure vessel piping upstream of boiler blow stop valves.

505-1.4.8.1 Overboard Discharge. Visually inspect overboard discharge piping from outside the ship while the ship is in dry-dock. Remove sea growth between the inner and outer pipes and inspect the metal surfaces.

505-1.4.8.1.1 The boiler blow overboard discharge connections on most ships are either of the pipe-within-a-pipe design or a single carbon steel pipe welded to the hull. There are a few ships that have nickel-copper overboard discharge piping welded directly to the steel hull. In these cases, visually inspect the bimetallic welded joint between the nickel-copper pipe and steel hull plating according to NSTM Chapter 074, Volume 1, **Welding and Allied Processes** . Where localized corrosion at the nickel-copper weld and steel interface reduces the steel member below its design thickness, grind the corroded areas to sound metal and restore the excavation by welding according to NSTM Chapter 074, Volume 1.

505-1.4.8.1.2 The overboard discharge connections on ships receiving the reengineered boiler blow system are of the pipe-within-a-pipe design. For these overboard discharges, visually inspect the inner surface of the outer pipe. Where extensive pitting exists, estimate and record the maximum pit depth. Recoating of this surface with cold spray or brush zinc coating is recommended. Apply standard underwater hull coatings over the zinc coating. (See NSTM Chapter 631, Volume 1, **Preservation of Ships in Service - General**). The inner pipe is not part of the pressure boundary and is designed for replacement during an overhaul period. During each overhaul, remove the inner pipe and examine it for corrosion and/or erosion damage; replace as necessary. Replacement inner pipes shall be manufactured to the requirements of NAVSHIPS DWG 803-4444658, except that the length of the replacement pipe shall be taken from the removed pipe.

505-1.5 REPLACEMENT CRITERIA AND STANDARDS

505-1.5.1 GENERAL. Replace piping (pipe, valves, fittings) if previous records indicate that because of continued deterioration, its thickness will drop below the required minimum for safe operation before the next scheduled overhaul period. Thickness inspection reports for deteriorated piping shall be maintained by the ship for comparison purposes. The required thickness for safe operation of boiler blowdown, boiler soot blower, 1200-/600-psi high-pressure steam drain piping, and submarine piping shall be in accordance with paragraph 505-1.5.2, paragraph 505-1.5.3, paragraph 505-1.5.4 and paragraph 505-1.5.1.4. All other piping shall be in accordance with paragraph 505-1.5.1.3.

505-1.5.1.1 Ships having sections of piping with wall thicknesses below the specified minimum, and where the substandard piping cannot be replaced immediately, shall operate that portion of the system with special attention, and a departure from specifications should be requested. Record and replace such substandard piping at the first availability.

505-1.5.1.2 For piping systems, other than specified herein, replacements shall be of the same material and thickness as originally installed.

505-1.5.1.3 Renew piping, other than specified herein, when ultrasonic inspection conducted according to paragraph 505-1.4.4 through 505-1.4.4.3.1 by a shipyard, tender, or other suitable facility, indicates that the wall thickness is below the required thickness. Minimum wall thickness is calculated using the following formula:

$$T_m = (PD)/[2(S+YP)]$$

where:

T_m	Minimum wall thickness, inches
P	System design pressure (lb/in.^{2})
S	Maximum allowable stress in material due to internal pressure at design temperature (lb/in.^{2})
D	Outside diameter, inches
Y	A dimensionless coefficient having values as given in table 505-1-1.

Table 505-1-1. VALUE OF Y

Type of Material	Temperature °F					
	900 and lower	**950**	**1,000**	**1,050**	**1,100**	**1,150 and higher**
Ferrous	0.4	0.5	0.7	0.7	0.7	0.7 steel
Austenitic	0.4	0.4	0.4	0.5	0.5	0.7 steel
Nonferrous	0.4 metals					

505-1.5.1.3.1 Table 505-1-2 and Table 505-1-3 provide S values in ksi units. The ksi units must be multiplied by 1000 to convert them into lb/in.^{2} units as required for use in the above formula. The following conditions also apply:

1. If pipe or tubing is to be welded, Tm shall not be less than .109 inch wall thickness required for welding unless otherwise approved by NAVSEA 59074-AR-GIB-010/278, **Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels** .
2. P shall not be less than 100 for ferrous materials.
3. P shall not be less than 50 for nonferrous materials.
4. S shall not exceed that listed in table 505-1-2 and table 505-1-3. For submarines, refer to applicable new construction specifications. (Applicable Project Peculiar Document (PPD) may be used as an option to MIL-STD-438 and MIL-STD-777 to identify the applicable material specification).
5. When the calculated value of T_m is 0.050 inch or less use 0.050 for T_m .

505-1.5.1.3.2 An example of minimum thickness requirements is as follows. A 4-inch, schedule 80, 600-psi steam line operates at 600 degrees F. The original material is MIL-P-24691/1, **Tube and Pipe, Carbon Steel, Seamless** , ASTM A106, grade B. A check of the thickness using the formula gives the following:

T_m	PD /[2(S + YP)]
P	600 psi

D	outside diameter 4.5″ = (for 4″ pipe)
S	15 ksi (from table 505-1-2 for MIL-P-24691/1, ASTM A106, grade B)
Y	0.4 (from table 505-1-1, for ferritic below 900)
T_m	600 (4.5)/[2 (15,000 + 0.4(600))]
T_m	0.0885 (calculated)

505-1.5.1.4 Inspect submarine piping systems under the submarine piping surveillance program and repair according to NAVSEA SL730-AA-OMI-010, **Conduct of Surveillance of Submarine Piping Systems** .

505-1.5.2 BOILER BLOWDOWN PIPING SYSTEMS. The boiler blowdown piping system is separated into three areas:

1. Pressure Vessel Piping. The piping from the pressure vessel drum or header up to and including the first valve off the pressure vessel drum or header.

NOTE

This valve is referred to as the boiler blow stop valve to avoid confusing it with other nonpressure vessel valves in the downstream portion of the boiler blowdown system.

Table 505-1-2. MAXIMUM ALLOWABLE STRESS FOR FERROUS PIPE AT VARIOUS TEMPERATURES

Pipe or Tube Description			Temperature, Deg. F/S Value, KSI (See Note 2)																	
Material	**Specification**	**Classification**	**100**	**200**	**300**	**400**	**500**	**600**	**650**	**700**	**750**	**800**	**850**	**900**	**950**	**1000**	**1050**	**1100**	**1150**	**1200**
Welded (see Note 1)																				
Carbon Steel	ASTM A53	Type F	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.5										
	ASTM A53	Type E/Gr A	10.2	10.2	10.2	10.2	10.2	10.2	10.2	9.9	9.1	7.6								
	ASTM A53	Type E/Gr B	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.2	11.0	9.2								
	MIL-S-22698	CI D	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.3	8.3	6.8								
Seamless																				
Carbon Steel	ASTM A53	Type S/Gr A	12.0	12.0	12.0	12.0	12.0	12.0	12.0	11.6	10.7	9.0								
	ASTM A53	Type S/Gr B	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.4	13.0	10.8								
	ASTM A106	Gr A	12.0	12.0	12.0	12.0	12.0	12.0	12.0	11.6	10.7	9.0								
	MIL-P-24691/1	Type A, B, C, D	12.0	12.0	12.0	12.0	12.0	12.0	12.0	11.6	10.7	9.0								
	ASTM A106	Gr B	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.4	13.0	10.8								
	MIL-P-24691/1	Type E	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.3	12.9	10.8								
Stainless Steel-Welded (see Note 1)																				
18Cr-8Ni	ASTM A312	Gr 304	15.9	13.3	11.9	11.0	10.3	9.7	9.5	9.4	9.2	8.9	8.8	8.6	8.4	8.3	8.0	7.5	6.5	5.1
18Cr-8Ni	ASTM A167	Gr 304	15.9	13.3	11.9	11.0	10.3	9.7	9.5	9.4	9.2	8.9	8.8	8.6	8.4	8.3	8.0	7.5	6.5	5.1
18Cr-8Ni	MIL-P-24691/3		15.9	13.3	11.9	11.0	10.3	9.7	9.5	9.4	9.2	8.9	8.8	8.6	8.4	8.3	8.0	7.5	6.5	5.1
16Cr-12Ni-2Mo	ASTM A312	Gr 316	15.9	13.7	12.4	11.3	10.6	10.0	9.8	9.6	9.5	9.3	9.2	9.2	9.1	9.0	8.9	8.7	7.9	6.3
16Cr-12Ni-2Mo	ASTM A167	Gr 316	15.9	13.7	12.4	11.3	10.6	10.0	9.8	9.6	9.5	9.3	9.2	9.2	9.1	9.0	8.9	8.7	7.9	6.3
16Cr-12Ni-2Mo	MIL-P-24691/3	Gr 316	15.9	13.7	12.4	11.3	10.6	10.0	9.8	9.6	9.5	9.3	9.2	9.2	9.1	9.0	8.9	8.7	7.9	6.3
18Cr-10Ni-Ti	ASTM A312	Gr 321	15.9	13.5	12.0	10.9	10.2	9.6	9.5	9.3	9.2	9.1	9.0	9.0	8.9	8.8	7.8	5.8	4.2	3.0
18Cr-10Ni-Ti	ASTM A167	Gr 321	15.9	13.5	12.0	10.9	10.2	9.6	9.5	9.3	9.2	9.1	9.0	9.0	8.9	8.8	7.8	5.8	4.2	3.0
18Cr-10Ni-Ti	MIL-P-24691/3	Gr 321	15.9	13.5	12.0	10.9	10.2	9.6	9.5	9.3	9.2	9.1	9.0	9.0	8.9	8.8	7.8	5.8	4.2	3.0
18Cr-10Ni-Cb	ASTM A312	Gr 347	15.9	14.6	13.6	12.7	11.9	11.4	11.2	10.9	10.9	10.8	10.7	10.7	10.6	10.6	10.1	7.7	5.2	3.7
18Cr-10Ni-Cb	ASTM A167	Gr 347	15.9	14.6	13.6	12.7	11.9	11.4	11.2	10.9	10.9	10.8	10.7	10.7	10.6	10.6	10.1	7.7	5.2	3.7
18Cr-10Ni-Cb	MIL-P-24691/3	Gr 347	15.9	14.6	13.6	12.7	11.9	11.4	11.2	10.9	10.9	10.8	10.7	10.7	10.6	10.6	10.1	7.7	5.2	3.7
18Cr-10Ni-Cb	QQ-S-766	Gr 347	15.9	14.6	13.6	12.7	11.9	11.4	11.2	10.9	10.9	10.8	10.7	10.7	10.6	10.6	10.1	7.7	5.2	3.7
18Cr-8Ni	ASTM A312	Gr 304L	13.3	11.3	10.1	9.3	8.7	8.2	8.0	7.9	7.8	7.7								
18Cr-8Ni	MIL-P-24691/3	Gr 304L	13.3	11.3	10.1	9.3	8.7	8.2	8.0	7.9	7.8	7.7								
16Cr-12Ni-2Mo	ASTM A312	Gr 316L	13.3	11.2	10.0	9.2	8.5	8.0	7.8	7.6	7.4	7.3	7.1							
16Cr-12Ni-2Mo	MIL-P-24691/3	Gr 316L	13.3	11.2	10.0	9.2	8.5	8.0	7.8	7.6	7.4	7.3	7.1							
Seamless																				
18Cr-8Ni	ASTM A312	Gr 304	18.7	15.6	14.0	12.9	12.1	11.4	11.2	11.0	10.8	10.5	10.3	10.1	9.9	9.7	9.5	8.8	7.7	6.0
18Cr-8Ni	ASTM A376	Gr 304	18.7	15.6	14.0	12.9	12.1	11.4	11.2	11.0	10.8	10.5	10.3	10.1	9.9	9.7	9.5	8.8	7.7	6.0
18Cr-8Ni	MIL-P-24691/3	Gr 304	18.7	15.6	14.0	12.9	12.1	11.4	11.2	11.0	10.8	10.5	10.3	10.1	9.9	9.7	9.5	8.8	7.7	6.0
18Cr-8Ni	ASTM A271	Gr 304	18.7	15.6	14.0	12.9	12.1	11.4	11.2	11.0	10.8	10.5	10.3	10.1	9.9	9.7	9.5	8.8	7.7	6.0
16Cr-12Ni-2Mo	ASTM A312	Gr 316	18.7	16.1	14.6	13.3	12.4	11.8	11.5	11.3	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.3	9.3	7.4
16Cr-12Ni-2Mo	ASTM A376	Gr 316	18.7	16.1	14.6	13.3	12.4	11.8	11.5	11.3	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.3	9.3	7.4
16Cr-12Ni-2Mo	MIL-P-24691/3	Gr 316	18.7	16.1	14.6	13.3	12.4	11.8	11.5	11.3	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.3	9.3	7.4
18Cr-10Ni-Ti	ASTM A312	Gr 321	18.7	15.9	14.1	12.9	12.0	11.3	11.1	10.9	10.8	10.7	10.6	10.6	10.5	10.4	9.2	6.9	5.0	3.6
18Cr-10Ni-Ti	ASTM A376	Gr 321	18.7	15.9	14.1	12.9	12.0	11.3	11.1	10.9	10.8	10.7	10.6	10.6	10.5	10.4	9.2	6.9	5.0	3.6
18Cr-10Ni-Ti	MIL-P-24691/3	Gr 321	18.7	15.9	14.1	12.9	12.0	11.3	11.1	10.9	10.8	10.7	10.6	10.6	10.5	10.4	9.2	6.9	5.0	3.6
18Cr-10Ni-Cb	ASTM A312	Gr 347	18.7	17.2	16.0	15.0	14.0	13.4	13.1	12.9	12.8	12.7	12.6	12.6	12.5	12.5	11.9	9.1	6.1	4.4
18Cr-10Ni-Cb	ASTM A376	Gr 347	18.7	17.2	16.0	15.0	14.0	13.4	13.1	12.9	12.8	12.7	12.6	12.6	12.5	12.5	11.9	9.1	6.1	4.4
18Cr-10Ni-Cb	MIL-P-24691/3	Gr 347	18.7	17.2	16.0	15.0	14.0	13.4	13.1	12.9	12.8	12.7	12.6	12.6	12.5	12.5	11.9	9.1	6.1	4.4
18Cr-8Ni	ASTM A312	Gr 304L	15.6	13.3	11.9	10.9	10.2	9.7	9.5	9.3	9.2	9.0								
18Cr-8Ni	MIL-P-24691/3	Gr 304L	15.6	13.3	11.9	10.9	10.2	9.7	9.5	9.3	9.2	9.0								

Table 505-1-2. MAXIMUM ALLOWABLE STRESS FOR FERROUS PIPE AT VARIOUS TEMPERATURES - Continued

Pipe or Tube Description			**Temperature, Deg. F/S Value, KSI (See Note 2)**																	
Material	**Specification**	**Classification**	**100**	**200**	**300**	**400**	**500**	**600**	**650**	**700**	**750**	**800**	**850**	**900**	**950**	**1000**	**1050**	**1100**	**1150**	**1200**
16Cr-12Ni-2Mo	ASTM A312	Gr 316L	15.6	13.2	11.8	10.8	10.0	9.4	9.1	8.9	8.7	8.6	8.4							
16Cr-12Ni-2Mo	MIL-P-24691/3	Gr 316L	15.6	13.2	11.8	10.8	10.0	9.4	9.1	8.9	8.7	8.6	8.4							
Alloy Steel Seamless																				
1-1/4Cr-1/2Mo	ASTM A335	Gr P-11	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.8	14.4	14.0	13.6	9.3	6.3	4.2	2.8		
1-1/4Cr-1/2Mo	MIL-P-24691/2	Gr P-11	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.8	14.4	14.0	13.6	9.3	6.3	4.2	2.8		
2-1/4Cr-1Mo	ASTM A335	Gr P-22	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.4	13.1	11.0	7.8	5.8	4.2		
2-1/4Cr-1Mo	MIL-P-24691/2	Gr P-22	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	14.4	13.1	11.0	7.8	5.8	4.2		

Notes:
1. For welded pipe or tube wherein radiography is specified for the seam weld, the allowable stress for the seamless pipe or tube may be used.
2. The allowable stress values in this table are based on the requirements of ASME B31.1 Power Piping Code, 1995 Edition. In absence of specific NASEA guidance to modify or upgrade, the as-built minimum wall thickness based on original shipbuilding specification requirements, or as depicted on approved selected record drawings or system diagrams, is also acceptable.

2. Blowdown Piping. The piping from the outlet flange connections of the boiler blow stop valves to the outlet flange of the overboard discharge stop valve.

3. Discharge Piping. The piping from the flange connections of the overboard discharge valve outlet to the skin of the Ship.

505-1.5.2.1 Piping Replacement Criteria. Replace piping, if required, at the next availability, but in no case more than 12 months from the date of inspection when wall thickness is equal to or less than that specified in table 505-1-4. Piping must be replaced before pressurizing boiler blowdown piping if wall thickness is equal to or less than that specified in table 505-1-5.

505-1.5.2.1.1 Replaced sections of piping shall be schedule 80 minimum and extend from nozzle to valve for pressure vessel piping and from fitting to fitting for blowdown and discharge piping. See paragraph 505-1.5.2.1.2 for exceptions in emergencies. See paragraph 221n(x) of NAVSEA S9AA0-AB-GOS-010, **General Specifications for Overhaul of Surface Ships (GSO)** , for exceptions regarding the boiler casing expansion bellows. Piping material shall be the same as currently installed - carbon steel or nickel-copper, except as noted in paragraph 505-1.5.2.2.

505-1.5.2.1.2 In an emergency, when complete replacement of a piping run cannot be accomplished due to lack of material or lack of sufficient time, a sectional replacement may be made. A sectional replacement is one in which the replaced section of piping does not extend from component-to-component. In this case, ″component-to-component″ means from the boiler (boiler blow stop valve) to the sea chest. The replaced section of piping shall be of the same size, material, and original (purchase) wall thickness as the existing piping. If material selected is not as specified in applicable blueprints/technical documents, the material shall be verified as suitable for the system service, pressure, and temperatures. Temporary sectional replacements can be made using pipe or tube having different material, size, and/or wall thickness requirements from existing piping. However, the pipe or tube shall be suitable for use at the existing system pressure and temperature. Temporary sectional replacements shall be replaced at the first availability to prevent degradation in system performance due to galvanic corrosion of dissimilar metals, flow restriction due to smaller diameter piping, or erosion at the transition in piping diameter.

Table 505-1-3. MAXIMUM ALLOWABLE STRESS FOR NONFERROUS PIPE MATERIALS AT VARIOUS TEMPERATURES (FOR SURFACE SHIPS ONLY)

Pipe or Tube Description			Temperature, Deg. F/S Value, KSI											
Material (see Note 5)	Specification	Classification	100	150	200	250	300	350	400	450	500	550	600	650
Seamless														
Copper (see Note 1)	ASTM B88	Annealed	6.0	5.1	4.8	4.8	4.7	4.0	3.0					
	MIL-T-24107	Annealed	6.0	5.1	4.8	4.8	4.7	4.0	3.0					
	ASTM B280	Annealed	6.0	5.1	4.8	4.8	4.7	4.0	3.0					
	ASTM B88	Drawn	9.0	9.0	9.0	9.0	8.7	8.5	8.2					
	MIL-T-24107	Drawn	9.0	9.0	9.0	9.0	8.7	8.5	8.2					
	ASTM B280	Drawn	9.0	9.0	9.0	9.0	8.7	8.5	8.2					
Seamless														
Brass	ASTM B43	Annealed	8.0	8.0	8.0	8.0	8.0	7.0	5.0	2.0				
	MIL-T-20219	Drawn	12.5	12.5	11.8	11.2	10.5	7.5	2.0					
Copper-nickel - Welded (see Note 2)														
70Cu-30Ni	MIL-T-16420	Type II 4 1/2 & Under	10.6	9.6	8.9	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	
70Cu-30Ni	MIL-T-16420	Type II Over 4 1/2 NPS	8.5	8.2	8.0	7.8	7.7	7.5	7.3	7.1	7.0	6.9	6.8	
90Cu-10Ni	MIL-T-16420	Type II 4 1/2 & Under	8.5	8.2	8.1	7.9	7.6	7.4	7.2	7.1	6.3	5.7	4.3	
90Cu-10Ni	MIL-T-16420	Type II Over 4 1/2 NPS	7.4	7.1	7.1	6.8	6.6	6.5	6.5	6.4	6.2	5.7	4.3	
90Cu-10Ni	MIL-C-15726	Sheet & Plate	7.4	7.1	7.1	6.8	6.6	6.5	6.5	6.4	6.2	5.7	4.3	
Seamless														
70Cu-30Ni	MIL-T-16420	Type I	12.0	11.6	11.3	11.0	10.8	10.6	10.3	10.1	9.9	9.8	9.6	9.5
90Cu-10Ni	MIL-T-16420	Type I	10.0	9.7	9.5	9.3	9.0	8.7	8.5	8.2	8.0	7.0	6.0	
Seamless														
Nickel-copper	MIL-T-1368	CI A	17.5	16.9	16.4	15.9	15.4	15.1	14.8	14.7	14.7	14.7	14.7	14.7
Seamless														
Aluminum	WW-T-700/5	Alloy 5086, 0	9.3	9.1										
	WW-T-700/5	Alloy 5086, 23	10.0	10.0										
	WW-T-700/5	Alloy 5086, 43	11.0	11.0										
	ASTM B210	Alloy 5086, 0	9.4	9.2										

Table 505-1-3. MAXIMUM ALLOWABLE STRESS FOR NONFERROUS PIPE MATERIALS AT VARIOUS TEMPERATURES (FOR SURFACE SHIPS ONLY) - Continued

Pipe or Tube Description			Temperature, Deg. F/S Value, KSI											
Material (see Note 5)	Specification	Classification	100	150	200	250	300	350	400	450	500	550	600	650
	ASTM B210	Alloy 5086, 23	13.3	9.9										
	ASTM B210	Alloy 5086, 43	14.6	10.8										
Welded (see Notes 2 & 3) - Seamless (see Note 4)														
Ni-Cr-Mo-Cb	ASTM B443	Alloy 625 Ann.	27.0	27.0	27.0	27.0	27.0	26.2	25.4	24.8	24.3	24.0	23.8	23.6
	ASTM B444	Alloy 625	30.0	30.0	30.0	30.0	30.0	29.1	28.2	27.6	27.0	26.7	26.4	26.2
	ASTM B446	Alloy 625	30.0	30.0	30.0	30.0	30.0	29.1	28.2	27.6	27.0	26.7	26.4	26.2
Titanium														
Seamless Pipe	ASTM B337 or B861	Grade 2	12.5	12.0	10.9	9.9	9.0	8.4	7.7	7.2	6.6	6.2	5.7	---
Welded Pipe	ASTM B862	Grade 2	10.6	10.2	9.3	8.4	7.7	7.1	6.5	6.1	5.6	5.3	4.8	---
Welded Plate/Sheet	ASTM B265	Grade 2	12.5	12.0	10.9	9.9	9.0	8.4	7.7	7.2	6.6	6.2	5.7	---

NOTES:

1. For temperatures up to 406°F, the value given at 400°F may be used.
2. For welded pipe or tube wherein radiography is specified for the seam weld, the allowable stress for the seamless pipe or tube may be used.
3. For temperatures from 700 °F to 1,000 °F, the allowable shall be 23.4 ksi.
4. For temperatures from 700 °F to 1,000 °F, the allowable shall be 26.0 ksi.
5. When drawn or tempered nonferrous materials are used in welded or brazed construction, the maximum allowable stresses shall not exceed the values given herein for annealed material at the temperature shown.

Table 505-1-4. BOILER PIPING WALL THICKNESS REPLACEMENT CRITERIA

	Minimum Thickness (inches)	
	Nominal Operating Pressure (psi)	
System Location	600	1200
Pressure Vessel	0.115	0.130
Boiler Blowdown	0.115	0.130
Discharge	0.130	0.130

Table 505-1-5. MINIMUM BOILER PIPING WALL THICKNESS BEFORE PRESSURIZING

	Minimum Thickness (inches)	
	Nominal Operating Pressure (psi)	
System Location	600	1200
Pressure Vessel	0.090	0.110
Boiler Blowdown	0.090	0.110
Discharge	0.110	0.110

505-1.5.2.2 Discharge Piping Replacement. Replacement piping shall be nickel-copper per MIL-T-1368, (**Tube and Pipe Nickel-Copper Alloy, Seamless and Welded)** , class A, schedule 80 minimum. Flanged nickel-copper valves shall be used. If flanged nickel-copper valves cannot be obtained, refurbish and reuse the existing carbon steel overboard, stop-check, and guarding valves until nickel-copper ones are obtained. Flanges and fittings shall be nickel-copper per QQ-N-281, **Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections** . Flanges shall be socket or butt welded per ANSI B16.5, B16.11, or B16.9. Bimetallic piping shall be joined by flanges; do not use bimetallic welds. Spiral-wound gaskets per MIL-G-24716, **Gaskets, Metallic-Flexible Graphite, Spiral Wound** and nickel-copper fasteners per NSTM Chapter 075 shall be used in all flanges.

505-1.5.2.2.1 Replace overboard discharge hull penetrations per NAVSHIPS DWG 803-4444659 and 803-4444618.

505-1.5.2.3 Pressure Vessel Piping. Refer to NSTM Chapter 221 and NAVSEA 0951-LP-031-8010, **1200 Psi, Main Boilers, Steam Propulsion Plant; Repair and Overhaul** , for information on maintenance and repair of pressure vessel piping.

505-1.5.3 PROPULSION BOILER SOOT BLOWER PIPING. Main propulsion boiler soot blower piping consists of all piping located between the soot blower steam inlet (root) valve and the soot blower heads, including all drain lines. Inspection of boiler soot blower piping is required to ensure conformance to NAVSHIPS DWG 804-841336.

505-1.5.3.1 Refer to table 505-1-6 for minimum thickness replacement criteria. Consult system diagrams to identify the piping material installed.

505-1.5.3.2 Replacement piping shall be schedule 80 carbon steel according to the requirements of MIL-P-24691/1, type E or ASTM A 106, grade B for all systems with source steam from a boiler pressure auxiliary steam main. Replacement piping shall be chrome-moly steel according to the requirements of MIL-P-24691/2, class I, or ASTM A 335, grade P-11, for all systems with source steam from the main steam system. All soot blower piping, excluding the drain lines and piping located below the deck plates, shall be insulated according to MIL-STD-769, **Thermal Insulation Requirements for Machinery and Piping** . Welding shall be according to NAVSEA S9074-AR-GIB-010/278, **Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels** .

505-1.5.4 1,200 LB/IN. ^{2} (NOMINAL) 600 LB/IN. ^{2} (NOMINAL) HIGH-PRESSURE STEAM DRAIN PIPING. Refer to table 505-1-6 for the minimum thickness replacement criteria. Replacement piping shall be at least schedule 80.

NOTE

High-pressure drain piping for this criteria is from the source of drainage on the steam system up to the cutout valve downstream of the steam trap (or orifice).

505-1.5.4.1 Piping Replacement. Replacement piping shall be of the same material as that originally installed.

Table 505-1-6. SOOT BLOWER AND HIGH-PRESSURE STEAM DRAIN PIPING REPLACEMENT CRITERIA (FOR SURFACE SHIPS ONLY)

		Thickness (Inches) for Internal Pressure (see Note 4)					
		600 lb Nominal Pressure			1200 lb Nominal Pressure		
Size (NPS)	Nominal Outside Diameter (inches)	Carbon Steel (see Note 3)	Carbon Moly (see Note 1)	Chrome Moly (see Note 2)	Carbon Steel	Carbon Moly (see Note 1)	Chrome Moly (see Note 2)
1/4	0.540	0.070	0.070	0.070	0.070	0.070	0.070
3/8	0.675	0.070	0.070	0.070	0.070	0.070	0.070
1/2	0.840	0.070	0.070	0.070	0.070	0.070	0.070
3/4	1.050	0.070	0.070	0.070	0.070	0.070	0.074
1	1.315	0.070	0.070	0.070	0.070	0.070	0.093
1-1/4	1.660	0.070	0.070	0.070	0.081	0.074	0.117
1-1/2	1.900	0.070	0.070	0.070	0.092	0.085	0.134
2	2.375	0.070	0.070	0.070	0.116	0.107	0.167
2-1/2	2.875	0.071	0.070	0.070	0.140	0.129	0.202
3	3.500	0.087	0.080	0.075	0.170	0.157	0.246
3-1/2	4.000	0.099	0.091	0.085	0.195	0.179	0.282

Table 505-1-6. SOOT BLOWER AND HIGH-PRESSURE STEAM DRAIN PIPING REPLACEMENT CRITERIA (FOR SURFACE SHIPS ONLY) - Continued

		Thickness (Inches) for Internal Pressure (see Note 4)					
		600 lb Nominal Pressure			1200 lb Nominal Pressure		
Size (NPS)	Nominal Outside Diameter (inches)	Carbon Steel (see Note 3)	Carbon Moly (see Note 1)	Chrome Moly (see Note 2)	Carbon Steel	Carbon Moly (see Note 1)	Chrome Moly (see Note 2)
4	4.500	0.112	0.103	0.096	0.219	0.202	0.317
5	5.563	0.138	0.127	0.119	0.271	0.249	0.392

Notes:
1. For drain piping operated on other than superheated steam.
2. For drain piping operated on superheated steam.
3. This column also applies to auxiliary boiler carbon steel soot blower and bottom blow piping in sizes up to 2-1/2 inch NPS.
4. In the absence of specific NAVSEA guidance to modify or upgrade, the as-built minimum wall thickness based on original shipbuilding specification requirements, or as depicted on approved selected record drawings or system diagrams, is also acceptable.

505-1.5.4.2 Emergency Replacement. In an emergency, when complete replacement of a piping run cannot be accomplished due to lack of material or lack of sufficient time, a sectional replacement may be made. A sectional replacement is one in which the replaced section of piping does not extend from component-to-component. In this case, ″component-to-component″ means from the source of drainage on the steam system up to the steam trap (or orifice). In this instance, make the replacement section the same size and material as the existing piping.

505-1.5.4.2.1 Do not perform a sectional replacement if piping of equal thickness to the originally installed material is not available.

505-1.5.4.3 Complete System Replacement. Carbon steel pipe bends of five diameters shall be used. If space limitations require a tighter bend, a three-diameter bend radius may be used. Bending acceptability standards shall be according to paragraph 505-7.6.2 through paragraph 606-7.6.2..

505-1.5.4.3.1 If space conditions do not permit use of a pipe bend, long radius elbows may be used. Use socket-welded elbows and fittings to connect blowdown piping, and to connect the sampling line into the root connection boss that is attached to the blow piping. Joint geometry for this boss shall be according to MIL-STD-22.

505-1.5.5 AUXILIARY BOILER PIPING. Refer to table 505-1-6 for the minimum allowable wall thickness replacement criteria.

505-1.6 MINIMIZE PIPING STRESSES

505-1.6.1 HYDRAULIC TRANSIENTS. Close valves slowly. Sudden stoppage or changes in the velocity and direction of fluids contained in piping systems will generate high pressures that may damage equipment.

505-1.6.1.1 Do not start pumps with their discharge valves fully open, when the downstream piping is empty. This avoids high-pressure transients that can damage piping and equipment. Other actions that minimize piping stresses include:

1. Draining condensate from steam lines before admitting steam
2. Maintaining check valve vacuum breakers in proper operating condition
3. Maintaining hydraulic and pneumatic valve operators to control valve opening and closing rates at specified values.

505-1.6.2 TEMPERATURE CHANGES. Uneven thermal expansion or contraction in a piping system subjected to sudden temperature changes results in stresses in the piping that can cause material damage or failure. In addition, sudden and excessive temperature change is the primary cause of gasket leakage.

505-1.6.2.1 Avoid Sudden Temperature Changes. To avoid sudden temperature changes:

a. Open bypass valves or crack open valves supplied without bypass valves.
b. During boiler lightoff and when placing a boiler on line, especially during cold plant conditions, ensure lightoffs are accomplished strictly in compliance with Engineering Operational Sequencing System (EOSS) and boiler technical manuals.
c. Prevent boiler carryover.
d. Open valves slowly.

505-1.6.2.2 Pressure and Temperature Changes. When pressurizing a piping system that requires gradual warming, bring as much of the system as possible to temperature at the same time. Open bypass valves around isolation valves, or isolation valves where no bypass valves are provided, before opening the valve that will admit pressure to the system. For steam system warmup information see paragraph 505-2.2.3.

505-1.6.3 WATERHAMMER IN SERVICE STEAM SYSTEMS. Water hammer is characterized by a loud metallic pounding noise. Water hammer can be caused by inadequate drainage of condensate or heating the piping too rapidly.

505-1.6.3.1 The design pressure (wall thickness) of naval steam and steam drain system piping has not, in the past, provided an allowance for the added stresses due to water hammer. As a result, failures have occurred, particularly in copper piping in the vicinity of silver-brazed joints where the material is weakest due to annealing during fabrication. The water hammer stresses, added to normal pressure stress, produce a bulge in the annealed section. As the annealed section bulges it becomes work-hardened, in some cases to the extent that further bulging does not occur. When bulged piping is discovered, evaluate it for suitability for further service. For evaluation criteria for bulged piping, see paragraph 505-1.4.7.

505-1.6.3.2 To prevent bulging of service steam piping in future ships, provide additional pipe wall thickness or stronger materials, as necessary, to keep water hammer stresses within allowable limits. For ships in service, it is important that persistent water hammer be eliminated. In steam supply lines this can be done by removing liquid condensate from lines through continuous drainage from low point traps and by installing steam separators to remove entrained condensate. Service steam drain systems are very prone to water hammer because the fluid is near boiling temperature and distance and elevation changes are great, resulting in significant pressure fluctuation as the fluid flows to its receiver. Ships' forces can try to combat waterhammer in drain piping by selectively securing equipment in an attempt to locate the source, and then ensuring that controls and traps are functioning properly. Beyond this, request technical assistance from a Fleet Technical Support Center.

505-1.6.4 PIPING STRAINS. Do not use piping as handholds, footholds, or to support weights. This also applies to voice tubes, pneumatic tube dispatch piping, and other similar piping. Where necessary, install suitable guards to prevent such actions.

505-1.7 CROSS-CONNECTION VALVES BETWEEN SIDE TANKS

505-1.7.1 The relatively slow rate of transfer through an open cross-connection and the changes in relative tank height with rolling of the ship do not make the effects of an open cross-connection readily apparent. However, if a list develops because of flooding or other reasons, the list will be increased by the transfer of fluids through the open cross-connection. Unless system or ship operation dictates otherwise, keep the cross-connection between side tanks shut, and indicate condition with appropriate signs, markings, and instructions.

505-1.8 FLOATING BALL CHECK VALVES FOR FUEL TANK SOUNDING TUBES

505-1.8.1 REQUIREMENTS. Floating ball check valves are installed in fuel, JP-5, and oily waste tank sounding tubes. Refer to NSTM Chapter 541, **Petroleum Fuel Storage, Use and Testing** for installation requirements. Lube oil tanks do not require floating ball check valves.

505-1.8.2 DOCUMENTATION. Documentation on the floating ball check valve is as follows:

1. NAVSEA 803-5959276
2. NAVSEA Technical Manual 56435-JX-MMM-010, **Floating Ball Check Valve for Sounding Tubes, Installation, Operation and Maintenance, P/N 803-5959276.**

505-1.9 INSPECTION, REPAIR, AND TEST REQUIREMENTS FOR STEAM RECEIVERS, WET ACCUMULATORS, DRAIN RECEIVERS, AND TROUGH WARMUP RECEIVERS

See NAVSEA S9587-B1-MMA-010, Catapult Steam Support Systems For CV/CVN Class Ships; Description, Operation and Maintenance, for inspection, repair and test requirements for these systems.

SECTION 2

STEAM SUPPLY AND DRAINAGE SYSTEMS

505-2.1 GENERAL

CAUTION

In freezing weather secured system/components and auxiliary equipment and its piping exposed to freezing temperatures and not protected should be completely drained. If necessary, break drain connections to prevent damage due to freezing.

505-2.1.1 SYSTEM OPERATION. Steam systems generally are operated independently by machinery groups. Suitable connections are provided, however, so that some systems may be cross-connected for economy of operation during cruising, or for emergency operation due to equipment casualty or battle damage.

505-2.1.2 FASTENERS. All steam systems designed for temperatures above 775°F (fossil-fueled ships) or for main steam system design pressure (nuclear-powered ships) will require level I (material control standard) fasteners in accordance with NSTM Chapter 075, **Threaded Fasteners** . See Appendix A for acceptance criteria for in-service inspections of fasteners in bolted joints in steam piping systems of fossil fueled surface ships.

WARNING

Ensure fasteners are of proper material. Black oxide coated brass can be mistaken for steel.

505-2.2 STEAM SYSTEM DESIGN

505-2.2.1 MAIN AND AUXILIARY STEAM SYSTEMS. On most fossil fueled ships, main steam system design conditions are either 600 lb/in. ^{2} and 454°C (850°F) or 1,200 lb/in. ^{2} and 565°C (1,050°F). Steam for auxiliary service is taken directly from the boiler drum internal desuperheater and reduced as necessary for services through reducing stations. Boiler pressure auxiliary steam systems have been provided to furnish steam to auxiliaries designed for this pressure (such as forced draft blowers and port and cruising feed pumps).

505-2.2.2 IN-LINE DESUPERHEATERS. Where the steam temperature has to be reduced because of the limitations of the service, desuperheaters have been installed in conjunction with each pressure-reducing station. Some in-line desuperheaters are provided with high-temperature alarms to warn when an unsafe condition exists.

505-2.2.3 STEAM SYSTEM WARMUP. Incorporate the following steps into all operating procedures covering warmup of steam systems:

a. Cycle all valves to ensure they are operational. Leave them in the open position for at least 1 minute to permit drainage of condensate from the body into the line.

b. Open all drains on the valve bodies and piping.

c. Line up system for warm-up according to the existing operating procedures.

NOTE

Leave all valve body drains open throughout the warm-up period to permit drainage. Position other drains according to existing operating procedures.

d. Proceed with warm-up operation and close valve body drains when completed.

505-2.2.4 IN-LINE DESUPERHEATER PROBLEMS. Refer to existing desuperheater technical documentation for troubleshooting procedures. The following guidance is provided to assist in correcting in-line desuperheater problems if other technical documentation cannot be located:

a. Check that temperature controller is operating and properly calibrated. Temperature setpoint should be 390 degrees F.

b. Connect a separate 20 lb/in. ^{2} variable air supply to the water-regulating valve actuator. Vary the air pressure from 0 to 20 lb/in. ^{2} and back to 0; the valve shall be fully closed at 3 lb/in. ^{2} and fully open at 15 lb/in. ^{2} and operate smoothly without sticking or binding. Adjust stroke and clean valve stem as necessary according to applicable technical manual.

c. Inspect and clean desuperheater nozzles.

d. Repair 1,200/150 or 600/150 pressure-reducing valves if constant pressure cannot be maintained.

e. Check location of temperature sensor. Sensor should not be less than 20 feet downstream of the desuperheater.

505-2.2.4.1 In-Line Desuperheaters. In-line desuperheaters are not required on surface ships when the maximum boiler desuperheater outlet temperature is 600 degrees F or less. Boiler desuperheater outlet temperature data is available in the applicable main boiler technical manual.

505-2.2.5 BOILER BLOWDOWN VALVE OPERATION. The proper operational sequence of boiler blowdown valves is given in NSTM Chapter 221, **Boilers** .

505-2.2.5.1 Blowdown Valve Location. On older boiler blowdown systems, some or all of the blow valves are inaccessible from the deckplates. When system replacement is required, consider either reinstalling the present blow valves with their stems in a vertical position so they are accessible and operable from the deckplates, or replacing existing angle valves with globe valves (conforming to MIL-V-17737, Valves, Boiler Blow, Shipboard Use) to ensure accessibility.

505-2.2.5.2 Blowdown Valve Operation. To aid in the operation of some boiler blow valves, a removable T-handle wrench is permitted and may be furnished with the valves. Do not use remote operating gear with boiler blow valves. However, other system valves may be equipped with a reach-rod-type remote operating gear.

CAUTION

To prevent damage to soot blower piping, allow sufficient time for gradual and thorough warmup of soot blower steam and drain piping before steam

Caution - *precedes*

is admitted to the soot blowers. If this precaution is not observed, the piping may be subjected to thermal shock that will induce excessive thermal stresses. This may result in failure of the piping.

505-2.2.6 SOOT BLOWER OPERATION. NSTM Chapter 221 contains details concerning use of soot blowers and examination of soot blower heads to ensure their safe condition. NAVSEA DWG 804-841336 provides installation requirements for soot blower piping systems.

505-2.2.7 SHORE STEAM CONNECTIONS. Deck connections are provided for supplying steam from shore for various services aboard ship. In port, with the main plant shut down, shore steam is supplied to the service steam systems. These connections also are used to supply steam to a boiler for starting up under cold ship conditions.

505-2.2.7.1 Ensure that hose couplings and clamps are satisfactorily attached before installation. Securely lock lugs on hose clamps over the collar on the nipple (the part that fits inside and projects out from the hose end). The surface of the collar, against which clamp lugs bear, shall be square for a good grip.

505-2.2.7.2 Since rubber has a tendency to relax in storage, tighten clamp bolts. Pull up each nut evenly. Again, check collar alignment. After several hours of steaming, tighten bolts again; however, do not overtighten.

505-2.2.7.3 Test each length of hose with clean fresh water at a pressure of at least 500 lb/in. ^{2} before initial installation, and in accordance with Planned Maintenance System (PMS) thereafter.

NOTE

Where PMS is implemented, conduct preventive maintenance according to Maintenance Requirement Cards (MRCs).

505-2.2.7.4 Blisters in the hose cover may appear. Such blisters generally are just under the cover and do not affect the strength of the hose. Secure the steam and pierce the blisters (with suitable safety precautions) to relieve the pressure. Such piercing of the rubber cover should not impair the life of the hose if the inner tube and wire braid reinforcement remain intact.

505-2.2.7.5 If the ship-shore steam riser does not contain a strainer, ensure that a strainer with pressure gauges is installed at the deck connection and that the strainer basket is clean. The strainer will prevent particle contamination of the ship service steam system. When receiving steam from shore or tender through a rubber hose, clean the strainer if the pressure drop across the strainer exceeds 20 lb/in. ^{2} .

505-2.2.7.6 Do not confuse interlock construction metal hose with the corrugated (or bellows) type. Do not use interlock construction metal hose for steam service.

505-2.2.7.7 Turn deck connections at the ship side to face outboard wherever possible so that no hose is carried aboard. Where the deck connection extends out beyond the deck edge, attach an elbow facing downward. This will permit the hose to hang freely in a U-loop for maximum service life and safety.

WARNING

Serious injury to personnel may result if steam is not bled from the hose before it is uncoupled; when disconnecting shore steam hose a valve connection is provided to facilitate this operation.

505-2.2.7.8 Install the hose without twists or sharp bends. Carry a minimum length of hose aboard and provide a suitable means to secure the hose body (close to the couplings) to a rigid member as a safeguard against hose whipping.

505-2.2.8 CATAPULT STEAM SYSTEM. Steam is taken from the main steam system for charging catapult dry receivers and wet accumulators (see NAVSEA 59587-B1-MMA-010, **Catapult Steam support System for CV/CVN Class Ships; Description, Operation and Maintenance**) .

505-2.2.8.1 The life and dependability of the dry receivers is increased by minimizing the extent of pressure and temperature fluctuations. During warm-ups, do not fill the receiver to a pressure greater than that anticipated for use during catapult operation. Whenever possible, gradually increase the receiver pressure after a no-load launch to that required for aircraft launching according to established warm-up rates.

505-2.2.8.2 A quick-closing valve is installed in the catapult steam supply line in the machinery space to protect the boilers from excessive pressure drop. Excessive pressure drop can result from damage to the catapult piping system or low boiler steaming rates. The valve is usually pneumatic motor-closed, solenoid-actuated, and quick-closing. It will automatically shut off the catapult steam supply when the main steam pressure falls below a predetermined value. The valve may be manually or pneumatically actuated from the damage control deck.

505-2.2.8.3 High-pressure steam preheating is used to bring the launching engine cylinders up to operating temperature before initial firing of the catapult. This is done by space heating the insulated trough in which the cylinders rest. Condensate from the high-pressure steam heating coils normally is returned to the ship's high-pressure drain main.

505-2.2.8.4 In addition, heating steam from the ship constant service steam system is supplied for trough heating to prevent damage or corrosion that may be caused by moisture or freezing weather when the catapult is secured. Condensate is normally returned to the ship service steam drainage system.

505-2.2.8.5 The catapult is recessed in the flight deck; and therefore, there is always a danger that aircraft fuel spilled on the deck may collect in the trough below. Because of the fire hazard this presents, a steam-smothering pipe is installed throughout the length of the trough.

505-2.3 STEAM DRAIN COLLECTING SYSTEMS

505-2.3.1 GENERAL. Drain collecting systems are provided to remove condensate from steam piping systems and equipment and to collect fresh and contaminated water drainage from other services.

505-2.3.2 DESIGN. The majority of auxiliary ships built to maritime standards do not have the extensive drain collection system installation typically found on Navy ships. This is due to the basic difference in operation of the two ship types. Most of the underway steaming by commercial ships is at a steady rate while Navy ships are subject to frequent maneuvering.

505-2.3.3 HIGH-PRESSURE STEAM DRAINAGE SYSTEM. This system collects drainage from steam piping systems and steam equipment operating to pressures of 150 lb/in. ^{2} and above, and returns it to the deaerating feed tanks or feedwater heaters. (On submarines, high pressure steam drains are returned to the main condenser.) Each drainage branch line is fitted with a strainer, trap, or orifice and cutout valves. Bypassing these components is a warm-up branch line, which discharges to the fresh water drain collecting main or to the waste water drain collecting main.

505-2.3.4 SERVICE STEAM DRAINAGE SYSTEM. This system collects drainage from steam piping systems and steam equipment throughout the ship which operate at pressures under 150 lb/in. ^{2} . This includes services such as space heaters, laundry, tailor shop, and food service equipment.

505-2.3.4.1 Drainage from this system is discharged into the fresh water drain collecting tanks except that steam drainage from utility wool presses is discharged overboard. On large combatant ships such as aircraft carriers, the system discharges to service steam drain collecting tanks located in the machinery spaces. Where necessary, air ejectors are provided to maintain these drain tanks under a vacuum to ensure proper functioning of the drain system. The contents are discharged by level control devices to the condensate discharge system. In addition, the tank has gravity drainage connections to the waste water drain collecting tank in the same space.

505-2.3.5 OIL HEATING DRAINAGE SYSTEM. This system collects drainage from oil heating steam services and similar services, where the drainage may become contaminated with oil. This category includes fuel service heaters, fuel tank heating coils, and lubricating oil heaters.

505-2.3.5.1 On some ships, the oil heating drain collecting main will discharge to inspection tanks located in the vicinity of the deaerating feed tanks. The system is arranged so that drainage from any oil heating service can be discharged to any inspection tank. Each inspection tank, however, will discharge only to the deaerating feed tank in the same space. Inspection tanks are provided with additional connections arranged to discharge to the fresh water drain collecting system and to the oily water drainage system, if installed, or an oily water collecting tank.

505-2.3.5.2 Under normal operating conditions, discharge all drainage from the oil heating drainage system to the deaerating feed tanks or feedwater heaters through the inspection tanks. This will allow prompt detection of oil contamination to prevent oil from entering the feed system.

505-2.3.5.3 A small test valve is provided in the drain line from each of the oil heating services, so the source of oil leakage can be located and the damaged element isolated for repair.

505-2.3.6 FRESH WATER DRAIN COLLECTING SYSTEM. This system collects drainage from various propulsion plant piping systems and equipment operating in the machinery spaces at steam pressure under 150 lb/in. ^{2} , and service steam drainage system piping and components (see paragraph 505-2.3.4). This system serves components such as the turbine gland seal and exhaust piping, warm-up drains from noncondensing turbines, and air ejector condenser drains.

505-2.3.6.1 The system also receives drainage from pumps, steam systems, condensate systems, feed systems, and similar steam cycle services from which it is desirable to drain the water when the system is not in use.

505-2.3.6.2 On surface ships, drainage collected by this system is discharged to fresh water drain collecting tanks located in machinery spaces. The contents of these tanks are pumped into the condensate system upstream of the deaerating feed tanks or vacuum dragged into the main and auxiliary condensers. On submarines, low pressure steam drains are returned to the main condenser.

505-2.3.6.3 NSTM Chapter 220, Volume 2, **Boiler Water/Feedwater Test and Treatment** , prohibits retention of shore steam condensate for boiler feedwater. To enable discharge of shore steam condensate, ship installations have been provided with hose valves to enable the fresh water drain collecting pump to discharge condensate to the ship reserve feed riser and fill connection. The condensate may then be discharged either overboard or to the facility (or ship) supplying the steam.

505-2.3.7 CONTAMINATED DRAINAGE SYSTEM. A contaminated drainage system is installed in each main and auxiliary machinery space to allow the ship to pump bilges dry and to remain reasonably clean.

505-2.3.7.1 This system collects oil and water leakage from piping and equipment that normally operates with leakage, and drainage from other services, which at times may be contaminated. The system is arranged to discharge to tanks located in the space. Contents of these tanks are removed by means of the bilge drainage system on older ships and by separate pumps or gravity drainage on newer ships.

NOTE

On ships constructed after 1960, the contaminated drainage is separated into waste water (nonoily) and oily water drain systems. Each of these systems may be provided with their own drain collecting tanks and pumps, or either may be part of another system where gravity drainage to another tank is provided, or both.

505-2.3.8 POTENTIAL BOILER WATER CONTAMINATION. For those drain collecting systems in which funnels are used, take care to prevent backflow contamination from a collecting funnel to a system containing higher quality water. In particular, where vent or drain lines discharging to funnels serve piping, components, or tanks containing water that is returned to propulsion plant boilers or steam generators, each such vent or drain line shall end at least 1/2 inch above the top edge of the funnel. This rule applies even where the vent or drain line is normally isolated and pressurized upstream of the isolation valve, since almost any connection point may become depressurized or subject to slight vacuum during periods of plant shutdown or maintenance evolutions. Impure water siphoned under these circumstances may later be fed to the boilers.

SECTION 3

SEAWATER SYSTEMS

505-3.1 SEAWATER PIPING PRESERVATION

505-3.1.1 METALS USED IN SEAWATER SYSTEMS. The following practices tend to extend the life of all metals used in seawater systems:

1. Eliminate entrained air from seawater systems. Trapped air can promote corrosion and impingement attack.
2. Operate with minimum water velocities possible. Excess velocity results in erosion. Refer to paragraph 505-5.3 for acceptable water velocities.
3. Eliminate leaks. Internal leakage leads to wire drawing and erosion. External leakage leads to corrosion.
4. Insulate hangers from piping carrying fluids below 65°C(150°F) with sheet rubber hanger clamp liners.
5. Eliminate vibration or other mechanical damage to piping.
6. Eliminate damage to valves and adjacent piping by fully opening valves where throttling is not necessary.
7. Avoid subjecting piping with protective coatings (galvanized, tinned, solder-wiped) to heat, which would cause local destruction of coating and promote galvanic action.
8. Avoid using dissimilar metals in contact with each other, such as ferrous pipe plugs in nonferrous piping.

505-3.1.2 MARINE GROWTH. Removal of marine growth is necessary to minimize corrosion and to avoid loss of seawater flow due to a reduction in cross-sectional area and high velocities in partially blocked flow passages. Most common areas for excessive marine growth to occur include heat exchangers and downstream piping, and areas of low flow or stagnant seawater.

505-3.1.3 INSPECTION. At each drydocking, inspect sea chests and seawater sides of heat exchangers for marine growth. Each week, during periods between drydockings, check the differential pressure or discharge and, where provided, suction pressure readings of seawater pumps and heat exchangers for evidence of fouling. If fouling is suspected, inspect at the first opportunity.

505-3.1.3.1 Maintenance procedures included in this section supplement the Planned Maintenance System (PMS). Conduct preventive maintenance including schedules of tests, inspections, and overhaul cycles according to appropriate Maintenance Requirement Cards (MRCs).

505-3.1.3.2 At each regular shipyard availability, inspect representative sections of seawater piping systems for evidence of marine growth. This includes main and auxiliary circulating water piping, fire main and flushing system piping, and normally wet magazine sprinkling system piping. Inspection frequency can be adjusted based on observed rates of marine growth. Clean piping, as required, to return the system to its maximum efficiency. See paragraph 505-3.4.4.2 for acid cleaning of piping.

505-3.1.4 IDLE SYSTEM LAYUP. During extended idle periods in port (1 week or more), drain main and auxiliary seawater circulating branches not in use. Where it is impossible to drain a branch, operate it daily to prevent fouling. Refer to NSTM Chapter 254, **Condensers, Heater Exchangers, and Air Ejectors** , for steam condenser draining and layup procedures, or applicable system operating manuals such as the Steam and Electric Plant Manual (SEPM) or Ship System Manual (SSM). Refer to SEPM or SSM for lay-up requirements for seawater pumps and heat exchangers.

505-3.2 WASTER PIECES

505-3.2.1 SPOOLS AND ZINC BOXES. Protective spools and zinc boxes are no longer necessary in copper-nickel seawater piping. See NSTM Chapter 254 and Naval Sea Systems Command (NAVSEA) DWG 803-5959186 for information regarding the use of zinc anodes in heat exchangers. For sea chest waster sleeves, see paragraph 505-9.20.

505-3.2.2 GALVANIC CORROSION PROTECTION. In seawater piping systems having ferrous piping and nonferrous valves or fittings, galvanic corrosion will occur between the metals. The NAVSEA policy is to provide protection for ferrous pipe by installing a short section of removable piping on each side of nonferrous components; these sections are called waster pieces. In cases where waster pieces are not already installed, they shall be installed when repair is necessary. Desired length of waster pieces is 24 inches, but where space does not permit this length, a minimum of 12 inches is acceptable.

505-3.2.3 CONSTRUCTION. Unless otherwise specified, waster pieces shall be made of extra heavy, galvanized steel pipe, with flanges to facilitate renewal.

505-3.3 RUBBER EXPANSION JOINTS

505-3.3.1 ALIGNMENT. Rubber expansion joints are designed to accommodate various amounts of axial and lateral movement, depending on the size of the joint and the number of arches or corrugations built into the joint. Where these designed movements are exceeded, the life of the joint is materially reduced. Since normal pipe movement due to thermal expansion may be in such a direction as to place additional stress on a joint installed in a misaligned system, never install expansion joints to compensate for pipe misalignment. Use of pipe support devices to force misaligned pipes into position is prohibited.

505-3.3.2 INSTALLATION. Correct piping misalignment whenever measurements exceed the values given in Table 505-3-1 or whenever the expected movement (due to thermal expansion or ships structure deflection) added to any existing misalignment will exceed the values given in Table 505-3-1. Installing expansion joints between pipes misaligned for a coldset condition is acceptable, providing the specifications in the following paragraphs are observed.

505-3.3.2.1 Pipe movement due to thermal expansion moves the expansion joint to or through the neutral position. (The neutral position being the unloaded configuration of the joint, as manufactured.) Neither the designed coldset nor the pipe movement will exceed the designed movement of the expansion joint.

505-3.3.2.2 All rubber expansion joints shall meet the requirements of ASTM F1123, **Standard Specification for Non-Metallic Expansion Joints** , unless otherwise specifically approved by NAVSEA.

505-3.3.2.3 Specially shaped joints such as wedges, reducers, or joints with built-in offsets are not permitted unless specifically approved by NAVSEA. A request for approval for a specially shaped joint shall clearly state the necessity for such a joint and indicate why a standard joint would be unacceptable. Approval for specially shaped joints will be on a case-by-case basis only.

505-3.3.3 INSPECTION. Inspect all rubber expansion joints quarterly, giving special attention to the large diameter rubber expansion joints installed in the sea connections to and from the main condensers.

505-3.3.3.1 Table 505-3-1 provides data on the allowable movement of rubber expansion joints from the free or neutral position. Before installing, inspect all new replacement expansion joints for cuts, gouges, and other damage that exposes the reinforcement fabric. Check the expansion arch on the inside diameter of the expansion joint to ensure that it is of the open arch type.

Table 505-3-1. ALLOWABLE MOVEMENT OF SINGLE ARCH RUBBER EXPANSION JOINT

Size (inches)	Compression (Inch)	Elongation (Inch)	Lateral Deflection (Inch)
2 to 6	1/2	1/4	1/2
8 to 18	3/4	3/8	1/2
20 to 24	7/8	7/16	1/2
26 to 48	1	1/2	1/2

505-3.3.4 NEWLY INSTALLED. Immediately after installation, inspect the newly installed expansion joint for damage. If nicks, cuts, or gouges are found; and they expose but do not damage the reinforcing fabric more deeply than one layer of fabric, are not longer than 2 inches, and do not cover an area greater than 4 square inches; repair the expansion joint by applying synthetic rubber sealing compound.

505-3.3.5 EXISTING RUBBER JOINTS. Visually examine outer cover of joints for evidence of cracks. Shallow cracks in the cover that do not expose the reinforcing fabric of the expansion joint are not considered serious enough to warrant replacing the joint.

505-3.3.5.1 Closely examine cracks that expose the reinforcing fabric to determine the condition of the fabric. If reinforcing fabric is torn, cut, or otherwise degraded, replace the expansion joint at the earliest opportunity.

505-3.3.5.2 If reinforcing fabric is merely exposed, and does not show signs of being torn, cut, or otherwise degraded, the expansion joint may be left in service and replaced at the next availability of the ship.

505-3.3.6 MEASURING. Measure installed expansion joint using a modified carpenter square, as shown in figure 505-3-1, and a 6-inch ruler. Record data on an Alignment Inspection Worksheet (see figure 505-3-2). Modify the carpenter square to have a short arm 2-inches long, and a long arm, 18-inches long. Attach a metal block, 1/2-inch thick, to each side of the short arm. Use the procedure in the following paragraphs to measure expansion joint alignment.

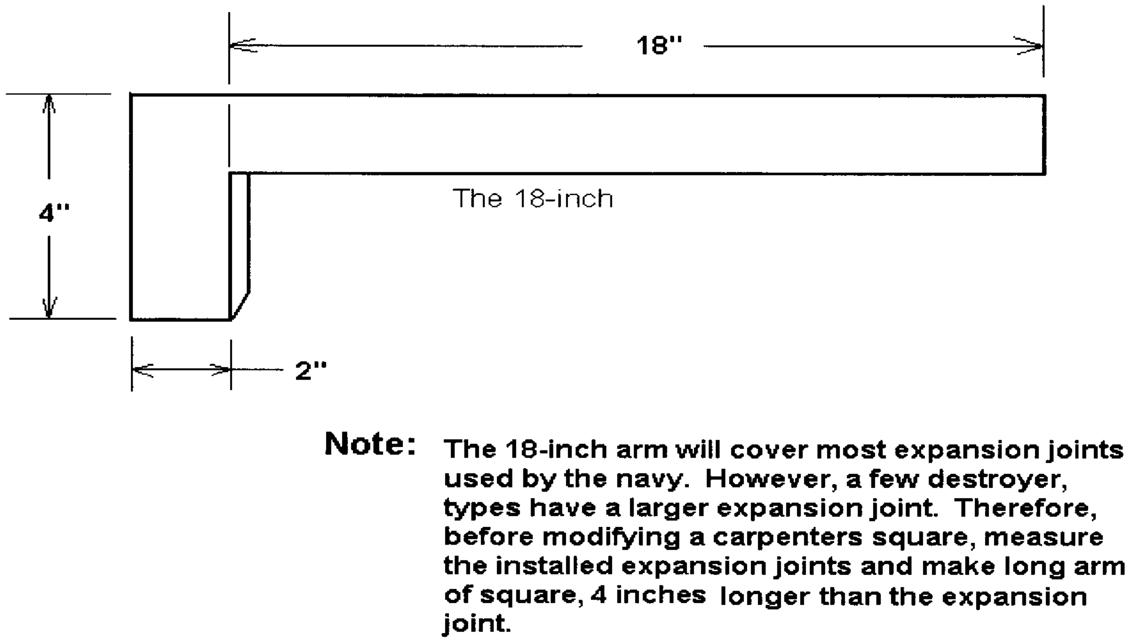


Figure 505-3-1. Modified Carpenter Square

505-3.3.6.1 Record the following information on the inspection worksheet:

1. Expansion joint manufacturer
2. Joint serial number
3. Application and size (for example, scoop injection 38 inches)
4. Whether joint is full of water or dry
5. Whether circulation pump is operating or not
6. Manufactured free length
7. Manufactured free configuration
8. Installed configuration.

505-3.3.6.2 Using a flange, hold the short side of the modified square against the flange. Position so the short side is perpendicular to the tangent of the piping surface and the long side of the square is running parallel to the axis of the expansion joint.

505-3.3.6.3 Measure the face-to-face distance on the long arm of the square at 12, 3, 6, and 9 o'clock positions around the expansion joint. If positions cannot be read because of supports, braces, or other interferences, measure any four locations approximately 90 degrees apart. Record readings on inspection worksheet.

Machinery Room No. ____________	Inspector ____________
MFR & Nominal Size ____________	Manufactured Free Configuration ____________
Serial No. ____________	Installed Configuration ____________
Application & Size ____________	Inlet Flange Circumference ____________
Joint Full of Water or Dry ____________	Outlet Flange Circumference ____________
Circ Pump Operating or Not ____________	Inlet Flange Diameter ____________
Manufactured Free Length ____________	Outlet Flange Diameter ____________

	Face-to-Face	Offset
12 O'clock		
3 O'clock		
6 O'clock		
9 O'clock		

Figure 505-3-2. Alignment Inspection Worksheet (Example).

505-3.3.6.4 Holding the square as indicated in paragraph 505-3.3.6.2, measure the net lateral offset with the 6-inch ruler and record on the inspection worksheet. Measure and record the circumference of the inlet and outlet flanges using a flexible tape measure. Multiply the circumferences by 0.318 to determine the diameters. Any difference in the diameters of the inlet and outlet flanges should be considered when evaluating the measured lateral offset.

505-3.3.6.5 The carpenter square method of measurement is inherently inaccurate to some extent and the recorded measurements should be considered as approximations for identifying possible misalignment. Refer to the Type Commander for resolution of measurements that indicate the expansion joint has a permanent set in excess of one-half the allowable movement shown in table 505-3-1.

505-3.3.6.6 Ships force should maintain the alignment data readings for the life of each specific joint. These readings can help industrial activities evaluate expansion joint alignment when readings are taken in a drydocked condition. They will also show movement over time.

505-3.3.7 REPLACEMENT. Replace rubber expansion joints in normally unmanned spaces at least every 6 years.

505-3.3.7.1 Replace rubber expansion joints in manned spaces at least every 10 to 12 years and check internally for cuts, gouges, and other defects during each 5-year period. For small diameter joints, this requires removing the expansion joint from the system. Large diameter joints, such as those found in condenser piping, can frequently be checked from inside the condenser heads.

505-3.4 FIRE MAIN, SPRINKLING, AND VOID FLOODING SYSTEMS

505-3.4.1 GENERAL. Sprinkling systems, which are supplied from the fire main, protect ammunition magazines, special weapon spaces, missile magazines, turrets, airplane hangars, pyrotechnic storage, ready-service ammunition magazines, non fossil fueled main machinery rooms and reactor rooms from the effects of fire. For additional information see NSTM Chapters 079, Volume 2, **Damage Control - Practical Damage Control** ; and 555 Volume 1, Surface Ship Fire fighting, and 555 Volume 2, Submarine Fire fighting.

505-3.4.2 SPRINKLING SYSTEMS. Effective operation of sprinkling systems depends upon maintaining the full operating pressure of the fire main and keeping the system free of debris. For magazine sprinkler systems, see NAVSEA 59522-AA-HBK-010, **Magazine Sprinkling System, Description, Operation and Maintenance Handbook** . For hangar deck foam sprinkling systems, see NSTM Chapter 555, Volume 1, **Surface Ship Fire-fighting** .

505-3.4.3 RELIEF VALVES. A few ships have relief valves fitted in sections of the fire main. Where so fitted, lift by hand quarterly, and keep stem and spring corrosion free by careful cleaning and application of petroleum grease. For most ships, relief valves, other than those on turbine-driven and diesel-driven pumps, are no longer provided.

505-3.4.4 MARINE GROWTH. Many ships experience rapid fouling of fire mains and submarine seawater piping from marine growth, particularly those operating in tropical waters. In some cases, flow has been restricted as much as 90 percent. To minimize the effects of fouling, that is, reduced flow or frozen valves, use the flushing and acid cleaning procedures in the following paragraphs. For submarine seawater piping, use the high-pressure water jet and mechanical cleaning procedures.

505-3.4.4.1 Flushing. Flush the entire fire main every 3 months at nominal fire main pressure. Loosely attached marine growth can be removed by seawater velocities in the 3- to 6-feet-per-second range. Removal of firmly attached marine growth requires use of mechanical or acid cleaning methods. Flushing is accomplished by lining up the system to direct flow from several pumps in one end of the ship through a selected section of the system, while discharging through an adequate number of weather deck fireplugs at the opposite end of the ship. Pumps are then run in the other end of the ship with the fireplugs open on the opposite end of the system to reverse the flow in the piping. Flush when clean seawater is available.

505-3.4.4.1.1 Prior to flushing, consider isolating branches from the fire main that serve non-vital users or equipment containing small diameter piping. Debris flushed from the fire main may clog smaller diameter branch piping. Where branch piping cannot be isolated, bypass all regulating and pressure-reducing valves where possible. When flushing of the fire main is completed, inspect all branch piping regulating and pressure-reducing valves and strainers for clogging, and close bypass lines. Branch piping can now be flushed with a reduced risk of clogging.

505-3.4.4.1.2 During the flushing period, open and shut all main line, bulkhead, cross-connection sectionalizing, and riser cutout valves several times to free them of sea growth and ensure that they are not stuck in an open or closed position.

505-3.4.4.1.3 When operating in tropical waters or other areas and seasons with high fouling rates, perform the flushing operation weekly. Where facilities are available, flush weekly with water at 54 degrees C (130 degrees F) for 30 minutes.

505-3.4.4.2 Acid Cleaning. DOD-STD-2187, **Chemical Cleaning of Salt Water Piping Systems** , describes a procedure for acid cleaning of fire main piping and removal of marine growth and scale, without dismantling the piping. Cleaning may be done by a naval shipyard or an approved contractor. This method of cleaning is both economical and satisfactory.

505-3.4.4.2.1 Do not acid clean seawater piping if it contains components made of materials that are incompatible with the acid to be used in the cleaning procedure, unless the incompatible materials are removed or isolated before cleaning. In particular, do not clean submarine seawater systems containing ball valves fitted with Delrin seat rings (Dupont Delrin AF Fibre/Resin DE-588) with hydrochloric or sulfamic acid.

505-3.4.4.2.2 In some cases, such as when piping contains materials that are incompatible with these acids, or where piping is being dismantled for other reasons, mechanical or high-pressure water jet cleaning may be more economical.

505-3.4.4.2.3 Where excessive marine growth is experienced, lift valve bonnets at least every 6 months to permit inspection and removal of growth from seating surfaces.

505-3.4.4.3 High-Pressure Water Jet. High-pressure water jet equipment can be used for cleaning fire main pipes in accordance with paragraph 505-4.1.2.12.

505-3.4.5 TEST OF DAMAGE CONTROL VOID FLOODING VALVES. Test and report results of damage control void flooding valve testing according to MRCs. In addition, each time a ship is drydocked, and following any repairs made in dry dock, operate the valves from remote control stations, with personnel stationed to observe movement of valve stem or disc, either from within the void or outside the hull, as arrangement permits.

505-3.4.6 FLUSHING SYSTEM. In some ships, flushing systems are independent systems supplied by a flushing pump and a cross-connection from the fire main. In other ships, flushing systems are supplied from the fire main.

505-3.4.6.1 In all connections between flushing systems and the fire main, pressure-reducing valves and relief valves are provided to avoid imposing full fire main pressure on the flushing systems and fixtures. Examine these valves, together with other valves such as stop valves and check valves in the flushing systems, at least once a year to determine their condition with respect to freedom of operation and tightness of packing. Test relief valves to verify that they function at the pressure for which they are set.

505-3.4.6.2 If the valves are not performing satisfactorily, disassemble them and inspect the seat ring and elastomeric disc for wear and proper material. The seat ring should be Monel and the elastomeric disc should have a hardness of 70 to 80 durometer. Immediately before assembling seat ring into the valve body, coat both male and female threads with polysulphate chromate elastomer per MIL-S-81733, **Sealing and Coating Compound, Corrosion Inhibitive** , (supplied by Products Research and Chemical Corp., part no. 870A-1/2, NSN 8030-00-008-7207). Allow to cure for 30 minutes after assembly before wetting joint; where practicable, remove and reinstall upper guide bushing of valve using the same thread-coating procedure.

505-3.4.7 WASHDOWN SYSTEM. A ship may become contaminated from radioactive particles (fallout) from a nuclear explosion cloud. (Chemical and biological agents can provide a similar threat.) Once this material (fallout) comes to rest on a dry surface, it is practically impossible to remove without prolonged hosing and scrubbing, or in all probability, stripping all paint from the weather surfaces. Paint surfaces, although they appear smooth, are in reality, a rough surface consisting of cracks and crevices in which radioactive particles of fallout become embedded and are virtually impossible to remove. See NSTM Chapter 470, **Shipboard BW/CW Defense and Countermeasure** , for guidance on system operation.

505-3.4.7.1 By causing a film of water to flow over a painted area, cracks and crevices are filled with water. As the contaminants fall, they are trapped in the moving film of water and washed overboard.

Therefore, radioactive materials never reach the painted weather surfaces of a ship protected with a washdown system since these surfaces are continually wetted by flowing water.

SECTION 4
PLUMBING SYSTEM DRAINS

505-4.1 DECK DRAINS.

Deck drain valves normally are kept open and shall be closed only for damage control in accordance with their assigned classification. Deck drains connected to the plumbing system have a 2-inch water seal trap. Deck drains in collective protection system zones have 4-inch water seal traps.

505-4.2 DRAIN CLEANOUT CONNECTIONS.

Adequate cleaning of plumbing drains requires that a sufficient quantity of cleanout connections in horizontal pipe runs not more than 50 feet apart be installed in the system. Where additional cleanout connections are required to improve maintenance capability, their installation shall be authorized as an alteration equivalent to a repair. The use of cleanout connections located above the deck will improve maintenance access to the drainage system. Guidance on the installation of new cleanout connections is provided in paragraph 505-4.2.2 through paragraph 505-4.2.7.

WARNING

Personnel engaged in maintenance of plumbing system drains, where contact with sewage is possible, shall observe the following safety precautions, and shall have the required immunizations in accordance with BUMEDINST 6230.1 series and NAVMED P-5010-7. Personnel shall not smoke, eat, or drink before a thorough wash-up with hot water and soap.

505-4.2.1 Safety Precautions. When performing maintenance of plumbing system drains, where contact with sewage is possible, rubber gloves, rubber boots, and coveralls shall be worn. Before beginning maintenance, several plastic laundry-size bags shall be brought to the maintenance area. Upon completion of maintenance, the area and components shall be washed down with hot potable water and stock detergent and rinsed with seawater or fresh water. Personnel shall then move from the immediate maintenance area and remove protective clothing. Protective clothing shall then be placed in the plastic bags, with rubber boots and gloves going in one bag, and with fabric clothing going in another bag. Rubber boots and gloves shall be washed in hot potable water and stock detergent, and shall be rinsed with an approved disinfectant solution. Some approved disinfectant solutions are listed in NSTM Chapter 593, paragraph 593-4.2.15.5. Fabric protective clothing may receive normal laundering. In no case shall maintenance personnel walk through living, eating, working, or any manned spaces still wearing protective clothing, boots, or gloves. Before leaving the maintenance area, personnel shall thoroughly wash hands, lower arms, and face, in that order, with hot water and soap using the wash-up facilities provided in the area.

505-4.2.2 Above Deck Cleanout Connections. Locate cleanout connections above the deck at the junction of the vent and drain pipes, as shown in figure 505-4-1, views A through D. These connections allow for the insertion of a hand snake or motor-driven cleaners.

505-4.2.2.1 Cleanout connections are constructed using laterals (Y-tee-fittings) with a threaded cleanout plug in the branch positioned to facilitate mechanical cleaning. Connections are to be the same size and material as the vent piping.

505-4.2.2.2 Where the vent pipe is not an extension of the drain pipe penetration of the deck, install a sweep-tee or welded branch. Also install a standpipe extending above the flood rim of the fixture, a coupling and a plug or cap as shown in figure 505-4-1, view E.

505-4.2.3 Other Cleanout Connections. Except for commissary and medical spaces, install new cleanout connections where experience has indicated the need for frequent cleaning. Construction of new cleanout connections shall be similar to that of existing connections.

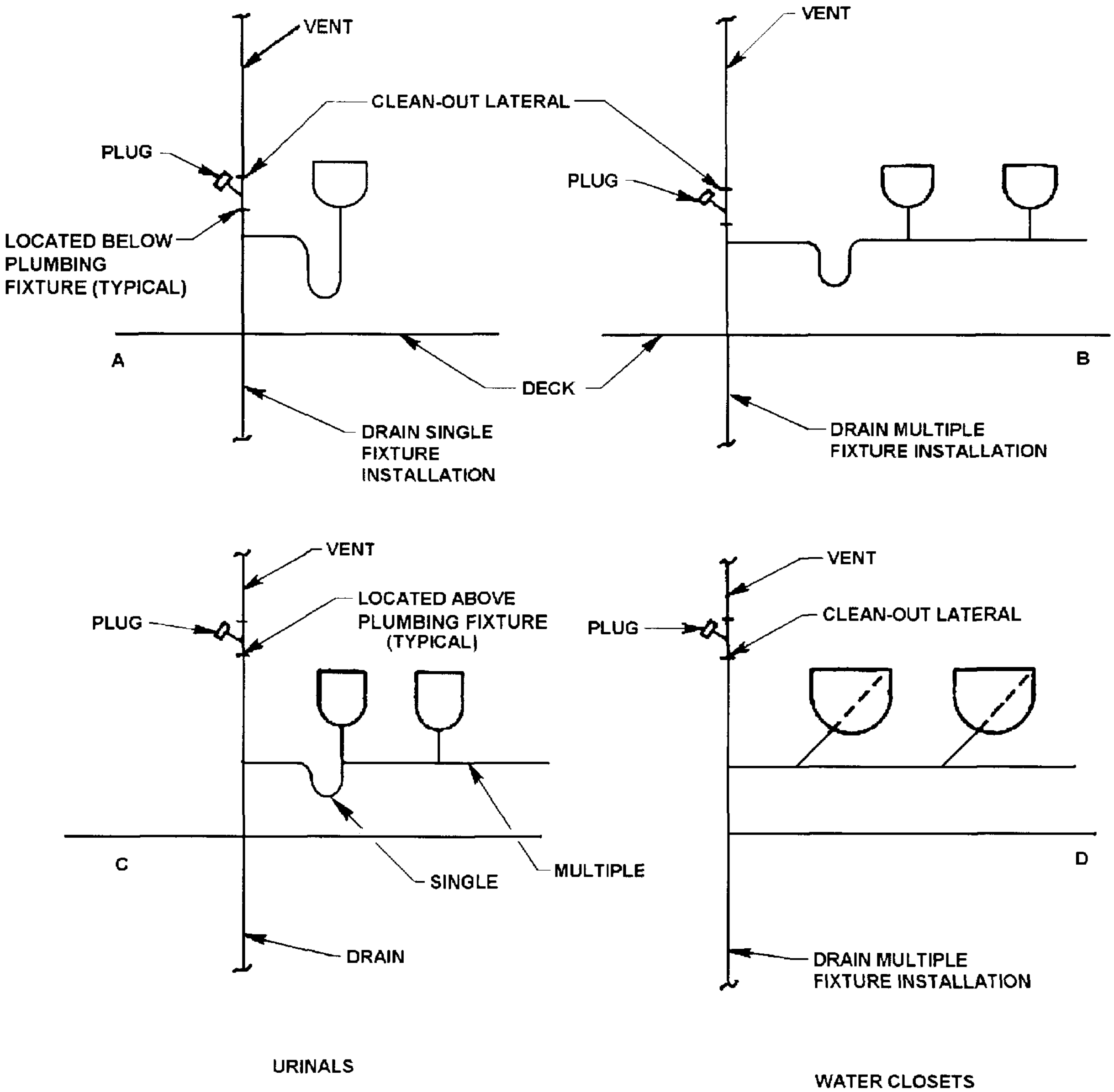


Figure 505-4-1. Typical Deck Cleanout Connection Locations (Sheet 1 of 2)

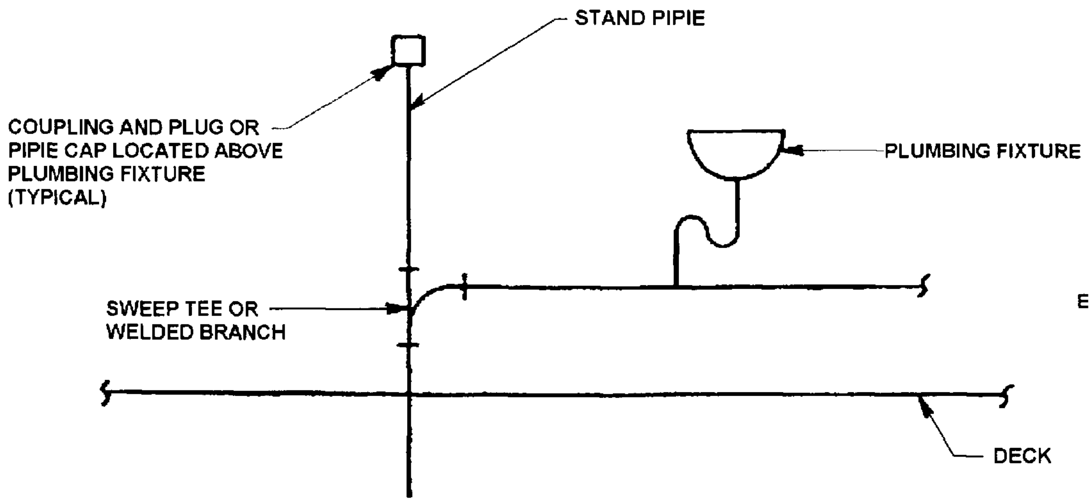


Figure 505-4-1. Typical Deck Cleanout Connection Locations (Sheet 2 of 2)

505-4.2.4 Commissary and Medical Space Cleanouts. In commissary spaces, where food is eaten, prepared, or stored and in medical spaces, install cleanout connections according to paragraph 505-4.2.2. Cleanout openings in the piping are to be located below all food service working surfaces to reduce dispersion of drain aerosols that may be created when the cleaning device is used.

505-4.2.4.1 Cleanout connections, associated with compartments located above commissary spaces, shall not be located in the overhead of commissary spaces. They may be installed in vertical drain piping below all food service working surfaces.

505-4.2.5 Access. Above-deck access to plumbing drains serving deck drains may be achieved by removing the strainer plate, as shown in figure 505-4-2.

505-4.2.6 Steamout Connections. The use of steam to clean plumbing drains is prohibited. On ships where steam is used for cleaning drains as a normal practice, the crew shall be instructed in the use of alternative cleaning methods. Remove and blank off steam piping, hose, and fittings installed for steam cleaning. Steamout connections on drain piping may be retained as cleanout openings or replaced by larger fittings suitable for a mechanical cleaner, with 1-1/4 inch Nominal Pipe Size (NPS) minimum.

505-4.2.7 Urinal Drains. Urinal drain piping problems may be caused by improper installation or close proximity of a heat source. Where drain piping is installed with insufficient pitch to drain (1/8 inch/foot minimum), clogging is probably caused by a biochemical reaction between urine and seawater which is accelerated in stagnant water. Modifying the drain pipe to a slope of 1/4 inch/foot may alleviate this type of problem. The close proximity of steam piping to a drain dries chemical deposits in drain piping into a rock-like substance. Relocation of the steam or drain piping will alleviate this problem.

505-4.3 PRACTICES AND PROCEDURES.

The following cleaning practices and procedures, together with good housekeeping and maintenance programs, should alleviate drain cleaning problems.

505-4.3.1 Do not allow garbage, grease, or oil to enter commissary drains. Keep sink and deck drain strainer plates in place during normal operation. Dispose of cooking oils, scrap fats, and meats through garbage grinders or with solid garbage.

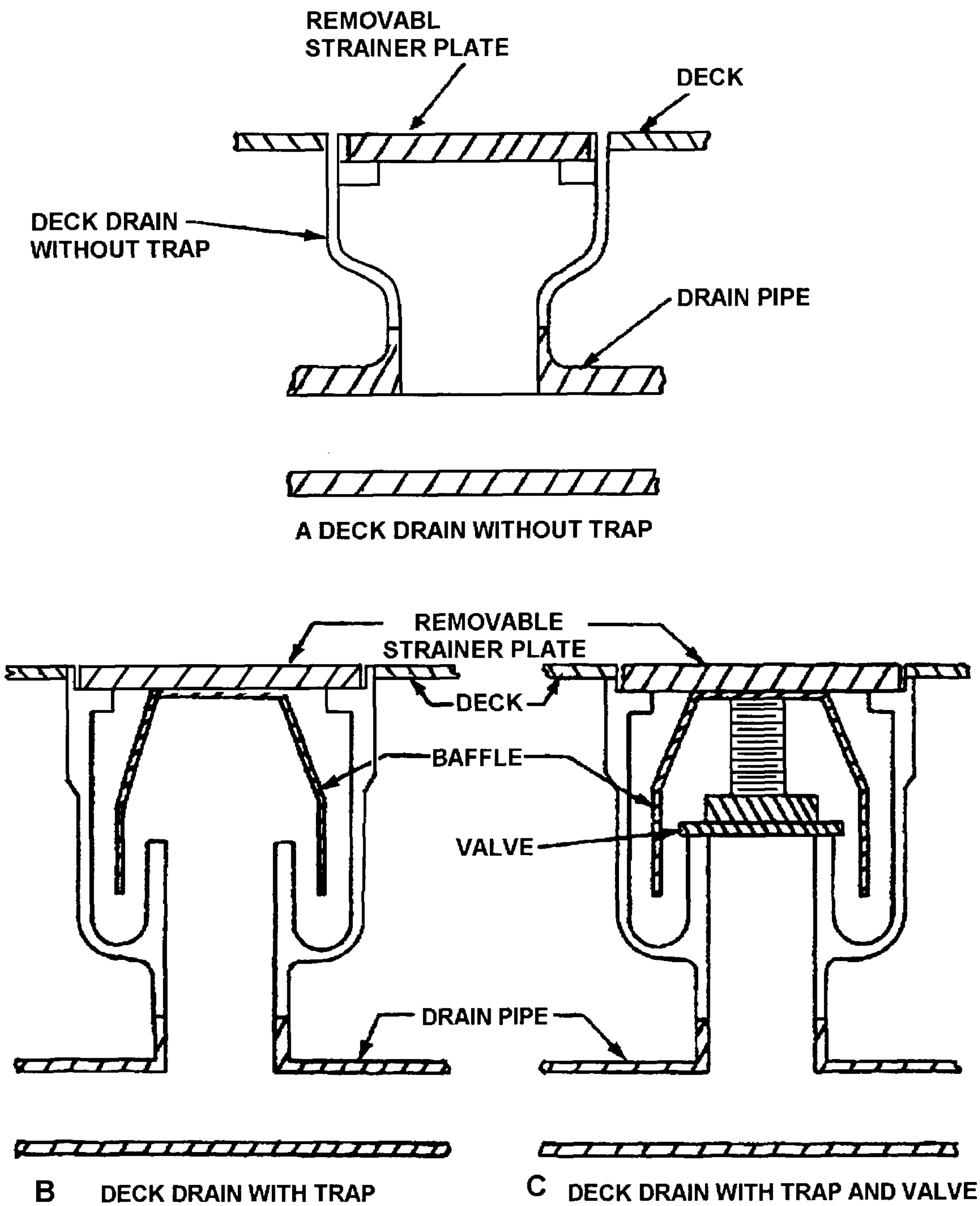


Figure 505-4-2. Typical Deck Drains

505-4.3.2 Flush commissary drains with a mixture of 130°F hot water and detergent for about 5 minutes, every 2 weeks. General purpose detergent, stock number 7030-00-282-9299, used at a concentration of 1/2 to 1 ounce/ gallon of water is suitable for this purpose. Such flushing will remove small amounts of grease and oil that may be present and prevent excessive buildup. Remove deck drain strainer plates and clean traps with hand tools before deck drains are flushed.

505-4.3.3 Avoid sweeping debris into deck drains during compartment sweepdowns. Fill deck drain traps with water periodically to prevent noxious gases from entering the compartment.

505-4.4 SCALE PREVENTION.

The established scale prevention procedure uses sulfamic-acid-based packets and dispensers which are identified on the urinal Allowance Parts List. These acid packets should be placed inside the sediment strainer (holder) and the entire unit installed in each urinal aboard ship. This action is outlined in the system Maintenance Requirement Cards (MRCs). The acid packet stock number is NSN 9G6850-01-150-4921 and the sediment strainer (holder) stock number is NSN 9C4510-01-164-3630. The acid packet will dissolve slowly as the urinal flushing water passes through the packet. The chemical action of the packet should significantly retard the formation of calcium carbonate scale on the wall of soil piping. Urinal bowls shall have a packet in the holder at all times to gain full benefit from the procedure. Only when a packet has completely dissolved should it be replaced by a new one. It should be noted that although residual acid may dissolve existing scale, the use of an acid packet is not considered a corrective maintenance procedure. Soil drain piping which experiences severe scale blockage should be hydroblasted according to paragraph 505-4.8. Package usage is most effective when it follows a system hydroblast cleaning.

505-4.4.1 Thoroughly flush urinal drains with fresh water at ambient temperature when entering a shipyard for prolonged availabilities or before securing to effect repairs. This prevents system dryout during downtime and the resulting scale hardening.

505-4.4.2 Do not apply hot water or steam to urinal drains. Deodorant cakes, if used, will liquefy in hot water temperatures and solidify in the drain at cooler temperatures, clogging drains.

505-4.4.3 Do not discard debris such as rags, wrappers, or newspapers, into water closets because they act as a dam and clog the drain.

505-4.4.4 Maintenance procedures included in this section supplement the Planned Maintenance System. Conduct preventive maintenance including schedules of tests, inspections, and overhaul cycles according to appropriate MRCs. Establish a preventive maintenance program to reduce scale buildup in urinal drains, which should be tested weekly, as discussed in paragraph 505-4.3.

NOTE

In testing a group of urinals served by a single plumbing trap, flush urinals simultaneously, if possible.

505-4.4.5 Flush each urinal served by a single plumbing trap and observe the flow from the basin. Overflow of the basin indicates a clogged urinal trap or drain. Perform corrective maintenance. Rapid lowering of the water level in the urinal basin indicates an unclogged drain and no further maintenance is required. A slow lowering of the water level in the urinal basin indicates a partially clogged drain. This condition may result from the formation of scale in drain traps or piping having a horizontal pitch less than 1/8 inch/foot, foreign material lodged in the drain, or a combination of foreign material and scale formation.

505-4.4.6 Try clearing the drain, using the cleaning solution described in paragraph 505-4.7. If two applications of cleaning solution do not appreciably improve draining rate, drain blockage is probably caused by foreign material. Use of a motor-operated rotary mechanical cleaner (snake) will be required to clear the drain.

505-4.4.7 Whenever it has been determined, either by periodic blocking or examination of the piping, that the cause of drain blockage is scale buildup, additional corrective maintenance is required.

505-4.5 USING ROTARY SNAKE DEVICE.

505-4.5.1 GENERAL. Surface ships experiencing chronic drain clogging problems may obtain a rotary snaking device to assist in cleaning drains. The addition of this device to the equipage allowance list for all surface ships has been authorized. It clears all types of drain blockages encountered and is safe to use within sound metallic plumbing systems, when all safety precautions are observed.

505-4.5.1.1 The Sewer Rooter Jr., Model 63, an approved and tested cleaner, manufactured by General Wire Spring Company, 1101 Thompson Ave., McKees Rocks, PA 15136, is a lightweight compact unit mounted on a hand cart. It consists of a rotating cable storage and drive drum that is belt-driven from a reversible motor and is equipped with a foot-operated pedal. It uses a variety of accessories to facilitate drain cleaning.

NOTE

This type cleaner shall not be used on systems composed of glass reinforced plastic pipe.

505-4.5.1.2 The 1/2-inch cable stored in the drum, with a spring-type head attachment, may be used for cleaning most drains. For small-sized drains, however, or where the 1/2-inch cable is not flexible enough to navigate the drain, 1/4-inch cable is recommended for cleaning.

505-4.5.1.3 Recommended accessories are the Spin-Feed attachments, which facilitate feeding the cable into the drain and the Slide-On Snakentainer with 1/4-inch cable, which facilitates changing to a smaller diameter cable.

505-4.5.1.4 When mechanically cleaning the system, locate the Sewer Rooter as close to the drain opening as practical. If it is not possible to get closer than 2 or 3 feet, run the cable through a 1-1/2 inch diameter section of pipe before insertion into the drain system; this prevents the cable from whipping. If a pipe section is not available, prevent whipping by holding the cable loosely at arms length while it is directed into the drain. This requires two people and each shall wear heavy rubberized gloves. While one holds the cable, the other directs it into the piping using the Spin-Feed. If the apparatus does not have a Spin-Feed, feed the cable slowly into the drain system by hand. A foot switch connected to the motor actuates the drum to rotate the cable in the drain.

505-4.5.1.5 If the cable encounters resistance, switch the motor into reverse using the toggle switch on the motor casing. After backing off a few turns, switch the motor into forward. Continue the forward and reverse action until the cable can pass through the line freely.

505-4.5.1.6 Once the system is unclogged and before cable removal, flush the drain with water. Place a rag, saturated with any petroleum-base lubricating oil around the cable to lubricate the cable as it is being withdrawn from the drain and rewound into the drum. Place the motor in reverse for withdrawal.

505-4.5.1.7 Where the drain is heavily clogged, the spring-type head attachment is replaced with the Arrow Head Starting Drill. When a channel has been started through the debris, cable is removed from the sewer line, and the starting drill is replaced with side cutters.

505-4.5.1.8 The Slide-On Snakentainer with 1/4-inch cable is used for navigating smaller drain lines or where sharp bends or other impediments prevent the 1/2-inch cable from traveling through the pipe. Although the 1/4-inch cable is considerably more flexible, it cannot withstand the same force that can be applied to the 1/2-inch cable. Exercise care with the smaller cable because it is more prone to kink.

505-4.5.1.9 Because the resistance of the 1/4-inch cable is not as great as that of the 1/2-inch cable, it is more difficult to determine when the 1/4-inch cable is jammed. To prevent jamming from occurring, do not force the cable into the drain. If cable is fed into the drain while jammed, it will cause kinking and subsequent breakage. Because the Slide-On Snakentainer does not have an automatic feed, use gloved hands to slowly feed the cable into the drain to be cleaned. Also treat the 1/4-inch cable with lubricating oil following a cleaning operation.

505-4.5.1.10 The cable will sometimes enter the wrong line at T-connections. Where several drain fittings are located in a relatively short section of pipe, the cable is likely to jam. Inserting the cable downstream of these fittings will avoid this problem.

WARNING

Personnel handling the snaking cable shall be extremely careful not to touch the mouth, eyes, or other parts of the face. Smoking, eating, drinking, or any other action that would transfer germs into the body is prohibited. Thoroughly clean hands following handling of the snaking cable.

505-4.5.2 PRECAUTIONS. Observe the following safety precautions when using rotary snakes:

1. Secure all spaces serviced by the drainage system being cleaned.
2. >Tag: OUT OF SERVICE., in accordance with S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL.**
3. Observe standard electrical safety precautions described in NSTM Chapter 300, **Electric Plant General.**
4. Ensure that the machine is electrically grounded by using a grounded receptacle and the three-pronged plug provided.
5. Do not operate machine foot pedal in water.
6. Wear heavy rubberized gloves when handling flexible cable.
7. Place unit within 2 or 3 feet of pipe opening to prevent cable whipping.

NOTE

If the unit cannot be positioned within this distance, run the cable through a 1-1/2-inch NPS pipe, to the pipe opening.

8. Exercise caution to prevent hands, hair, clothes, rags, or tools from becoming entangled in rotating belt drive.
9. Prevent kinking and snarling of the cable by making sure the locking pin is not pushed to the rear of drum.
10. Guide the flexible cable with an even pressure into the drain pipe and against obstructions.

NOTE

If the obstruction does not yield to firm pressure, reverse the motor and withdraw the cable a few feet, then try again. Excessive force will kink and break the cable.

11. Minimize cable slack to prevent whipping.

12. After each use, clean the cable with any petroleum-base lubricating oil as it is being removed from the pipe and rewound in the drum.

505-4.5.2.1 In commissary areas where food is prepared, eaten, or stored, take the following precautions:

1. Do not prepare or serve food in the compartment while drain piping is being cleaned or repaired.

2. Completely cover all food service equipment and working surfaces within the compartment while drains are being cleaned.

3. Following cleaning or repair of drain piping, thoroughly clean all food service equipment and working surfaces in the immediate area with detergent and fresh water and then wipe down with a solution of disinfectant [Food Service (Chlorine-Iodine type), stock number 6480-00-810-6396].

505-4.6 AIR PRESSURE PIPELINE CLEANERS.

For small blockages, use air-pressure pipeline cleaners to clear debris from piping and plumbing fixtures. Air impact and constant pressure type cleaners are available. The air impact type (stock number G4940-00-204-3738) clears debris through a quick release of compressed air. The constant pressure type (stock number G4940-00-293-8413) is designed to use 100 lb/in. ^{2} air to clear piping.

505-4.7 ACID CLEANING.

This procedure shall only be used to clean scale from pipe sections that may be removed and acid-soaked separate from the system.

WARNING

Personnel engaged in chemical acid cleaning treatment shall observe safety precautions. Rubber gloves and a full facepiece, air-purifying respirator equipped with filter (dust, fume, and mist) shall be worn during handling of dry acid or dry neutralizing compounds and mixed solutions. If cleaning solution comes in contact with the skin, the affected area shall be thoroughly washed with soap and water. If cleaning solution comes in contact with eyes; the eyes shall be rinsed thoroughly with clean water and medical attention immediately obtained. Hands and all exposed skin shall be thoroughly washed with soap and water at the conclusion of the acid cleaning procedure.

505-4.7.1 The use of commercial chemicals or any chemicals other than those described in paragraph 505-4.7.2 and paragraph 505-4.7.5 in any portion of the drainage system is prohibited. In the acid cleaning process, cleaning is done by soaking the scale with an acid solution. The piping system to be cleaned, therefore, shall be prepared as follows:

a. Remove pipe section that is to be cleaned.

b. Fill a bucket or suitable container with the acid solution described in the next paragraph.

c. Submerge pipe section that is to be cleaned in the acid solution.

505-4.7.2 Before mixing acid, estimate the volume of acid needed. In a drum, slowly add dry sulfamic acid (NSN 6850-00-637-6142) to hot fresh water in the ratio of 8 pounds (about 14 cups) of acid for each 4 gallons of water. Stir until acid is completely in solution. To reduce foaming, add 3/4 ounces of anti-foam solution similar to Dow Corning Anti-Foam B or General Electric Anti-Foam 60 to each 5 gallons of solution.

505-4.7.3 Continue soaking the pipe section until all visible reaction has stopped, or for 4 hours, whichever occurs first.

505-4.7.4 The scale-removing compound contains a chemical indicator which imparts a light red color to the fresh solution. As the acid reacts with scale, the color changes to orange and finally to yellow, at which time 95 percent of the acid has been consumed.

505-4.7.5 When the soaking period is completed, neutralize the waste solution (prior to removal of item being cleaned) by adding the same number of cups of dry neutralizing compound, anhydrous soda ash, FED Spec 0-S-571 **(Sodium Carbonate, Anhydrous, Technical)** , NSN 6810-00-262-8567, as dry sulfamic acid originally used. Commercial grade sodium carbonate is also acceptable. Let stand 15 minutes and dispose of neutralized solution. Flush component thoroughly with seawater and inspect.

505-4.7.6 If scale remains, the acid treatment should be repeated until it is clean.

505-4.7.7 The sulfamic acid described in paragraph 505-4.7.2 or toilet bowl cleaning compound (NSN 7930-00-559-9481) may be used for removing scale deposits and stains from porcelain fixtures.

505-4.8 HYDROBLAST CLEANING.

The most effective and the only NAVSEA approved method for cleaning calcium carbonate scale from collection, holding, and transfer piping is hydroblasting. Hydroblasting involves the use of a high-pressure waterjet machine which provides flow pressures of up to 10,000-pounds-per-square-inch gauge at the source. High-pressure water is introduced into the sewage lines through a flexible lance and nozzle. The impact of the water against the pipe interior pulverizes any scale or debris in the line. During this operation, the piping itself is not pressurized. By limiting the lance feed rate to one foot-per-minute, the pulverized scale is flushed from the system. This process requires cleaning out fittings at 50-foot intervals in the piping to minimize hydroblast pressure losses and maintain maximum cleaning effectiveness. Intermediate maintenance activities, tenders, shipyards, and other industrial activities including some private contractors have the capability to conduct hydroblast pipe cleaning. To schedule system hydroblasting, OPNAV 4790/2K should be submitted to a Readiness Support Group or a Maintenance Control Center. This will ensure that hydroblast cleaning is properly scheduled and that the appropriate hydroblast planning document has been prepared.

505-4.9 COMBINING DRAINS.

Soil drains such as those from water closets and urinals may only be combined with drains from showers, lavatories, or sinks in close proximity to the diversion valve that directs the discharge overboard or to the pollution control system (see NSTM Chapter 593, **Pollution Control**).

505-4.9.1 Do not connect waste pipes or drains from the following equipment directly to a plumbing drain unless an air gap is provided:

1. Refrigerator, steam table, or other receptacle where food is stored
2. Appliance, device, or apparatus used in the preparation of food or drink
3. Appliance, device, or apparatus using fresh water as a cooling or heating medium
4. Sterilizer, water still, fresh water treatment device, or potable-water-operated device.

505-4.10 PLUMBING VENTS.

All plumbing fixtures connected to the system shall have standard traps with water seals 2 to 4 inches deep. Such traps shall be adequately vented to drain properly and to prevent siphoning of the traps. Each fixture trap shall be served by a vent located such that the total pitch of the fixture drain from the trap weir to the vent opening is not more than one inside diameter of the fixture drain pipe. Where a stack vent meets these requirements, individual back venting is not required.

505-4.10.1 The developed length of the fixture drain line between the trap weir and the vent connection shall not be less than 2 nor more than 48 pipe diameters. All vertical drains shall be stack-vented from the highest point. Typical fixture piping and venting is indicated on NAVSHIPS DWG 810-1385920 through 810-1385923, inclusive.

505-4.10.2 High-velocity winds blowing into or across vent openings causes loss of seals or blowback of odors through traps because of the change in air pressure within the vents and plumbing system. This problem may be overcome almost completely by fitting half-round shields or tees at the open end of the vent. The run of the shields or tees shall be vertical rather than horizontal.

SECTION 5

MATERIAL SELECTION AND REPLACEMENT

505-5.1 GENERAL

505-5.1.1 MATERIAL SELECTION. Materials used in piping systems on ships built to Navy specifications meet commercial standards, where possible. Certain considerations, however, necessitate the use of higher order, more critical materials than would be required for a comparable commercial application. These include shock damage and the requirement for the lightest weight possible, consistent with good design. Generally, use of these more critical materials is restricted to combatant ships. In the case of seawater piping systems, however, the use of copper-nickel alloy material has become widespread because of its resistance to seawater corrosion.

505-5.1.2 FLUID TURBULENCE. Early deterioration may occur where fluid turbulence exists downstream of throttled valves or at sharp bends. Ledges and projections inside seawater piping systems operating at velocities above 12 feet/second (ft/sec) cause sufficient turbulence to erode copper-nickel tubing in a relatively short time; therefore, streamlined fittings and joints should be provided. See General Specifications for Overhaul 505b5 for maximum flow path protrusions.

505-5.1.3 MATERIAL IDENTIFICATION. To properly identify materials installed in piping systems, refer to the piping system arrangement drawings on file aboard ship. In addition, refer to piping system diagrams, Steam and Electric Plant Manual, Ship Information Book (SIB), and equipment manufacturers' technical manuals for detailed information on specific items.

505-5.2 DESIGN CONDITIONS

505-5.2.1 Piping and piping component minimum wall thicknesses are determined by considering the fiber stresses permitted for a material at the system design temperature and pressure, manufacturing tolerances, and corrosion allowances.

505-5.3 ACCEPTABLE FLUID VELOCITIES

505.5.3.1 In general, the size (diameter) of a piping system is based on pressure drop as determined by the available pressure head and flow requirements of the system. The velocity used in the calculations usually is left to the judgment of the designer. However, in certain systems, limitations are placed on the allowable velocity due to material considerations. For example, the fluid velocity at any point in all constantly running seawater and brine systems is normally restricted to the limits in table 505-5-1 to reduce the effect of erosion. Refer to the applicable system diagram in individual cases. The velocity of JP-5, gasoline, and F-76 is restricted to 15 ft/sec for shipboard transfer and to 25 ft/sec for loading and unloading operations. Suction piping velocities shall not exceed 4 ft/sec for lube oil systems.

505-5.4 REPLACEMENT MATERIALS

505-5.4.1 GENERAL. Unless otherwise specified, when a section of an existing piping system requires renewal, select the material according to the general considerations described in the following paragraphs.

Table 505-5-1. FLUID VELOCITY LIMITS

Pipe Size (NPS)	Velocity (fps)	Flow (gpm)
1/2	4.2	5.2
3/4	4.8	9.9
1	5.4	18.6
1-1/4	6.2	34.9
1-1/2	6.6	49.8
2	7.4	88.4
2-1/2	8.2	147
3	9.1	244
3-1/2	9.8	348
4	10.3	462
5	11.5	794
6 and larger	12.0	1187

NOTE

The velocity levels can be increased by approximately 2 fps for 70-30 copper-nickel alloys.

Minimum recommended seawater velocity for any pipe size in a flowing system is 3 fps.

505-5.4.1.1 Replacement material shall be of the same material, size, and wall thickness as the original. This avoids interfering with system design from the standpoint of system capacity and thermal expansion and contraction. It also prevents the possibility of setting up a galvanic couple between dissimilar materials with attendant electrolytic corrosion and precludes erosion resulting from interior misfit. For replacement of high pressure steam drain piping downstream of the orifice, replacement piping should be at least schedule-80. If the original piping was only schedule-40, replacement with schedule-80 is recommended when replacement is necessary. See paragraph 505-1.5.4 for high pressure steam drain piping upstream of the orifice.

505-5.4.1.2 Where service history indicates that whole portions of a system need replacing and where authorized by the Type Commander, make replacement on ships built to Navy specifications with material specified for the system involved. Piping and piping components shall comply with the material schedule specified in MIL-STD-777, **Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships** , for surface ships and MIL-STD-438, **Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service** , for submarines. (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.)

CAUTION

Do not use copper in diesel engine oil and fuel lines.

505-5.4.2 NONCONFORMING REPLACEMENT MATERIALS. When the replacement material does not conform to the requirements of paragraph 505-5.4.1, forward a complete report of shipboard conditions and attendant circumstances to the Naval Sea Systems Command (NAVSEA) for review.

505-5.5 PLUGS AND ADAPTERS

505-5.5.1 BACKGROUND. Damage to equipment and flooding of ship spaces may occur because of the failure of ferrous, brass, aluminum-bronze, or manganese-bronze plugs or adapters inadvertently installed in seawater systems. The primary cause is corrosion due to the dissimilar metal couples. A secondary cause is the use of unauthorized, tapered, threaded pipe connections. The correct material and use of straight threaded connections minimizes these failures.

505-5.5.1.1 For the purpose of this section, an adapter is an externally or internally threaded fitting that converts one type of connection to another (such as, MS THD X S.B. Union, MS THD X S.W. adapter, MS THD X Weld-base boss).

505-5.5.2 PLUG AND ADAPTER REQUIREMENTS.

505-5.5.2.1 General. When a repair or overhaul activity is performing the following authorized work in a seawater system (even if normally unpressurized; dry and/or vented) or any system or portion of a system that contains seawater or a mixture of seawater and other fluids, the use of threaded connections shall be per MIL-STD-438 or MIL-STD-777, as applicable, or as otherwise stated herein. (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.)

1. Installation of new piping or components
2. Modification or renewal of piping or components (replacement of nonserviceable or nonrepairable)
3. Overhaul of components.

505-5.5.2.2 Inspection Requirements. The requirements of this paragraph, including paragraph 505-5.5.2.2.1 and paragraph 505-5.5.2.2.2, apply only to submarines and to the machinery box of nuclear surface ships. The required inspections are listed in paragraph 505-5.5.2.2.1 and paragraph 505-5.5.2.2.2. Non-conforming plugs and adapters shall be replaced as described in paragraphs 505-5.5.4 through 505-5.5.4.3. (These inspection requirements are no longer applicable to non-nuclear surface ships or outside the machinery box of nuclear surface ships.)

505-5.5.2.2.1 Initial Inspection. All removed plugs and adapters within the work boundary of sea water systems shall be inspected. For the purpose of the initial plug and adapter inspection, ″within the work boundary″ is defined as the actual component or piping section being worked, or a component or section of piping being removed as interference for access to the authorized work area. The procedure for this inspection shall be as described in paragraphs 505-5.5.3 through 5.5.3.3.2. This inspection includes verification of correct material, thread form and locking device (if required).

505-5.5.2.2.2 Final Inspection. Perform a final inspection of all accessible plugs within the work boundary (including the test boundary) not more than 2 weeks prior to fast cruise. If fast cruise is not required, perform this final inspection not more than 2 weeks before completion of the availability. Final inspection for plugs and adapters during short availabilities is not required if the initial inspection was accomplished within 2 weeks prior to completion of the availability. Plugs that are expected to be inaccessible within 2 weeks of fast cruise shall be inspected before they become inaccessible. The intent of this final inspection is to verify that plugs installed during the renewal or overhaul are of the proper material and locking devices are in place, as required. Material identification shall be done in accordance with paragraph 505-5.5.3.1 or identification of marking(s) made during initial inspection. Removal of plugs and adapters is not required for this verification. This verification does not require removal of lagging not otherwise removed during the availability. Lagging which was not reinstalled in order to provide access for inspection shall be reinstalled at the earliest opportunity but not later than the end of the availability. Interim use of lagging pads is acceptable. Do not reapply lagging over plugs and adapters, to allow future access. Provide minimum size opening, directly over plug or adapter, that allows access for future maintenance. If non-conforming plugs or adapters are found by the above inspection, an expanded scope of inspections should be identified to and concurred with by NAVSEA.

505-5.5.2.3 Temporary Plugs. Use of nonconforming temporary plugs (except for foreign material exclusion) during the overhaul or repair period is prohibited. All applicable plugs, whether permanent or temporary, shall conform to the requirements of paragraph 505-5.5.2.1.

505-5.5.3 INSPECTION PROCEDURES. Following are the procedures for inspecting plugs and adapters in seawater piping and components on submarines and in the machinery box of nuclear surface ships.

505-5.5.3.1 Plug and Adapter Material. Verify material by using visual and acid spot checks, or MIC Level 1 markings.

505-5.5.3.1.1 Visual and Acid Spot Testing. For copper-nickel systems, determine whether plugs or adapters are of valve or tin bronze, copper-nickel, nickel-copper, or nickel-copper-aluminum. For Inconel or titanium systems, determine whether plugs or adapters are of like material. Verify material by using visual and acid spot checks. Copper-nickel (70-30), nickel-copper (70-30), nickel-copper-aluminum alloy (K-Monel), and titanium have a gray-silver color. Brass, bronze, aluminum bronze, manganese bronze, and 90-10 copper-nickel have a yellowish to reddish-brown color. Acid spot testing shall be accomplished in accordance with NAVSEA 0948-LP-045-7020 Volume 2, **Material Control Standard (Material Designators).**

NOTE

The acid spot test shall be performed only by those activities (such as shipyards or tenders with laboratory facilities or with industrial assistance) qualified to differentiate alloys by the color obtained during the test.

505-5.5.3.1.2 Acid Spot Test Limitations. Acid spot testing may be used to accurately identify broad classes of metal alloys. The spot test for tin bronze, however, is not entirely specific for this alloy because it may include brass-manganese-bronze in the category identified. A more specific identification by quantitative analysis is required, using either instrumental (spectrographic) or wet chemical techniques in a shipyard laboratory. Laboratory facilities are not always available, and where identification is uncertain, it is recommended that questionable material be replaced with fittings of known acceptable composition.

505-5.5.3.2 Plug and Adapter Configuration. Verify the correct thread form (straight thread or tapered), and locking device (if required). Removal of seal-welded or brazed plugs or adapters to determine if they are of the proper configuration (threaded type; tapered or straight) is not necessary if visual and acid spot checks show that the plugs or adapters are of the correct material.

505-5.5.4 REPLACEMENT CRITERIA - ALL SHIPS. All plugs and adapters not meeting the following requirements shall be removed and replaced.

505-5.5.4.1 Material. Plugs and adapters for copper-nickel systems (except those used in conjunction with pencil zincs) shall be of valve or tin bronze, copper-nickel, nickel-copper, or nickel-copper-aluminum. For Inconel or titanium systems like material shall be used. Series 300 CRES plugs and adapters, in CRES instrumentation piping downstream of the root valve, are acceptable when supported by applicable installation drawings. For plugs and adapters used with pencil zincs, see NSTM Chapter 254, **Condensers, Heat Exchangers, and Air Ejectors** . Material of plugs and adapters in heat exchanger or condenser heads shall be in accordance with the applicable drawing. Plugs for copper-nickel heat exchanger and distilling plant waterboxes shall be copper-nickel or nickel-copper, or as specified by the applicable drawings.

505-5.5.4.1.1 The only plug and adapter material presently stocked in the supply system is tin bronze (ASTM B-61). Table 505-5-2 stock numbers apply to this material and may be used for manufacturing plugs, when tin bronze is acceptable.

Table 505-5-2. MATERIAL STOCKED FOR PLUGS

Diameter (in.)	NSN
1	9Z-9530-00-7188
2	9Z-9530-00-7189
2-1/2	9Z-9530-00-7190
3	9Z-9530-00-7191

505-5.5.4.1.2 When required, obtain copper-nickel and nickel-copper per MIL-C-15726, Copper-Nickel Alloy, Sheet, Plate, Strip, Bar, Rod and Wire, or QQ-N-281, Nickel Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections, by local procurement.

505-5.5.4.2 Configuration. Plugs and adapters shall be straight thread, except where tapered pipe threads are permitted. Tapered pipe threads are defined in handbook H28, part II, section VII, Screw Thread Standards, and may be identified by some exposed threads (2 to 3 threads) at the connection. MIL-STD-438 and MIL-STD-777 specify the applicable areas where tapered pipe threads are permitted. (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.) Tapered and straight-threaded plugs are permitted in sizes 3/4 inch and smaller and used for applications where normal operating pressures do not exceed 50 lb/in. ^{2} in seawater systems. Plug or adapter threads must be compatible with boss threads. Replacement plugs and adapters shall have straight threads according to SAE J1926/1 and be fitted with O-ring seals. The seals used for these applications require 900 series dash number O-rings (90 durometer if available). Refer to NSTM Chapter 078, **Gaskets, Packing, and Seals** , for o-ring selection.

505-5.5.4.2.1 For normally depressurized gravity seawater systems (such as plumbing, collection portion of collection, holding, and transfer system, and weather/space drains) and normally dry or vented seawater systems and test equipment (such as dry sprinkling and brine rank sight glasses), the existing tapered or straight-threaded plugs and adapters may be retained provided the fittings are of the correct material. However, when plugs or adapters are replaced in the future, the replacements shall be of the material and thread type specified in paragraph 505-5.5.4.1 and paragraph 505-5.6.4.2 above. Where plugs or adapters never contact the fluid (for example, brine tank sight glass), they can be replaced in accordance with the applicable drawing or technical manual.

505-5.5.4.2.2 Where female connections and bosses have unauthorized tapered pipe threads, remove these threads and machine the connection and bosses according to **SAE J1926/1, Connection for General Use and Fluid Power - Ports and Stud Ends with ISO 725 Threads and O-Ring Sealing - Part 1: Threaded Port with O-Ring seal in Truncated Housing, Standard** , to accommodate the straight thread of MS 18229, **Plug for O-ring Gasket** , plugs. The outside diameter of bosses or other raised surfaces, after machining the straight thread, shall be equal to or greater than the F dimension per SAE J1926/1 for applicable thread size. Where machining for straight threads raises uncertainty as to the affect on the strength of the component pressure envelope, submit details to NAVSEA for resolution before machining.

505-5.5.4.2.3 Where future use of an existing threaded port is not required, the threads may be removed and solid plugs inserted and welded or brazed as appropriate. The fit-up requirements, inspection, and nondestructive testing criteria of NAVSEA S9074-AR-GIB-010/278, **Welding and Casting Standard** , for class P-1 or P-2 piping, or NAVSEA 0900-LP-001-7000, **Fabrication and Inspection of Brazed Piping Systems** , for class P-3a or P-3b, as appropriate, shall apply. Note however that salt water heat exchanger heads, of nickel aluminum bronze, that have been in service, tend to crack when welded or brazed. Therefore replacement of threaded plugs, with welded or brazed plugs, in these heat exchanger heads is not recommended.

505-5.5.4.3 Locking Devices. All plugs shall be locked in place with lock wire to prevent backing out under vibration. Welding or brazing of small eye fittings is acceptable if lock wiring is impossible due to plug location. Staking is not to be used as a locking method for MS 18229 plugs. Staking can damage the O-ring seal. Locking compounds shall be limited to emergency repair only. At the earliest opportunity, the plug shall be removed and an acceptable procedure for securing the plug (lock wiring) shall be accomplished.

505-5.5.5 REPORTING REQUIREMENTS.

505-5.5.5.1 Satisfactory completion of the above required seawater plug and adapter inspections, as well as any corrective actions needed for non-conforming materials, thread forms, or locking devices, shall be reported by letter to NAVSEA prior to fast cruise, or if fast cruise is not required, before completion of the availability.

505-5.5.5.2 Existing joint identification drawings for systems involved should be changed by the repair or overhaul activity to reflect what has been accomplished. Revision of drawings other than joint identification drawings to reflect the changes in plug material and design is not necessary.

SECTION 6

METHODS OF JOINT FABRICATION

505-6.1 GENERAL

Various joining methods and mechanical devices are used to connect piping to itself and other piping components. They include the following:

1. Welding. Current practice is to use welded joints in piping systems fabricated from carbon and alloy steels, copper-nickel, and other weldable piping materials.
2. Brazing. Brazed joints are also commonly used. However, use of brazed joints in fire hazardous areas is prohibited due to their poor performance under fire conditions. See paragraph 505-7.9.2 for restrictions regarding the use of brazed joints.
3. Flanges. Flanges are commonly used on piping components that must be removed for repair or replacement, such as valves, strainers, pumps, and compressors.
4. Unions. Unions are commonly used on piping components that must be removed for repair or replacement, such as valves, strainers, pumps, and compressors.
5. Mechanically Attached Fittings (MAFs). MAFs are fittings which are connected directly to pipe or tube by means other than welding, brazing, or threading. They are a cost effective alternative to doing hot work to join 2-1/2 inch and below piping systems. MAFs are discussed in paragraph 505-6.8.

These joining methods and mechanical devices are addressed in this section. Welded and MAF joints are usually preferred to brazed joints.

505-6.2 WELDING

505-6.2.1 GENERAL. NSTM 074, Volumes I and II, **Welding and Allied Processes and Nondestructive Testing of Metals, Qualification, and Certification Requirements for Naval Personnel** ; NAVSEA S9074-AR-GIB-010/278, **Fabrication Welding and Inspection and Casting Inspection and Repair for Machinery, Piping and Pressure Vessel for Ships of the United States Navy** ; and MIL-STD-22, **Welded Joint Design** ; contain basic requirements regarding such items as welding procedures, materials, safety precautions, and joint designs.

505-6.2.1.1 Welding should be performed only by qualified personnel.

505-6.3 BRAZING

505-6.3.1 GENERAL. NAVSEA 0900-LP-001-7000, **Fabrication and Inspection of Brazed Piping Systems** , contains requirements and recommendations for brazing of joints in piping systems. It includes information on joint preparation, brazing procedures, permissible brazing alloys, and inspection procedures for use with various material combinations. See paragraph 505-7.9.2 for restrictions regarding the use of brazed joints in fire hazardous areas.

505-6.3.2 END PREPARATION. Cut all tube or pipe ends, except refrigerant tubing, with a hacksaw or a metal cutting bandsaw.

NOTE

Wheel cutters are not satisfactory for cutting tube or pipe ends to be brazed into socket-type fitting ends. Either the cutter or the roller deforms the tube end so it is impossible to get the proper fit between the tube and fitting socket.

505-6.3.2.1 Cut all tube ends square so that when inserted into the fitting, the ends of the tubing will rest squarely against the shoulder or the stop in the fitting socket. Remove all burrs by reaming or filing. For refrigerant piping, cutting with a tube cutter is preferred. The use of any tool or abrasive material that produces filings, dust, chips, or other debris around refrigerant tube openings is not desirable.

505-6.3.3 SIZING. Size pipe or tube ends, where necessary, to provide the required radial clearance between the inside diameter of the socket and the outside diameter of the pipe or tubing to the values listed in NAVSEA 0900-LP-001-7000, Fabrication and Inspection of Brazed Piping Systems.

505-6.3.4 BRAZING METHODS. There are two methods of flowing the alloy into the brazed joint. NAVSEA 0900-LP-001-7000 specifies requirements and limitations for these methods which are:

1. Alloy insert method

2. Face-feed method.

505-6.3.4.1 Alloy Insert Method. With the alloy insert method of brazing, the alloy, in the form of an insert, has been preinserted into the socket. The insert is sized such that the required amount of alloy to fill the joint is provided. The brazing procedure is illustrated in figure 505-6-1. Both the socket and tube surfaces are heated to the proper brazing temperature, at which time the alloy will melt and flow into the brazing area. The alloy will not melt unless both surfaces are at the proper brazing temperature. If one surface is up to brazing temperature, while the other is not, the alloy will not flow because it will be cooled, or quenched, by the surface not yet up to brazing temperature.

505-6.3.4.1.1 Fittings shall be the preinserted ring type except as specified in MIL-STD-777, **Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships.**

505-6.3.4.2 Face-Feed Method. With this method of brazing, the alloy is stick fed by hand into the area to be brazed. The procedure for this method of brazing is illustrated in figure 505-6-2.

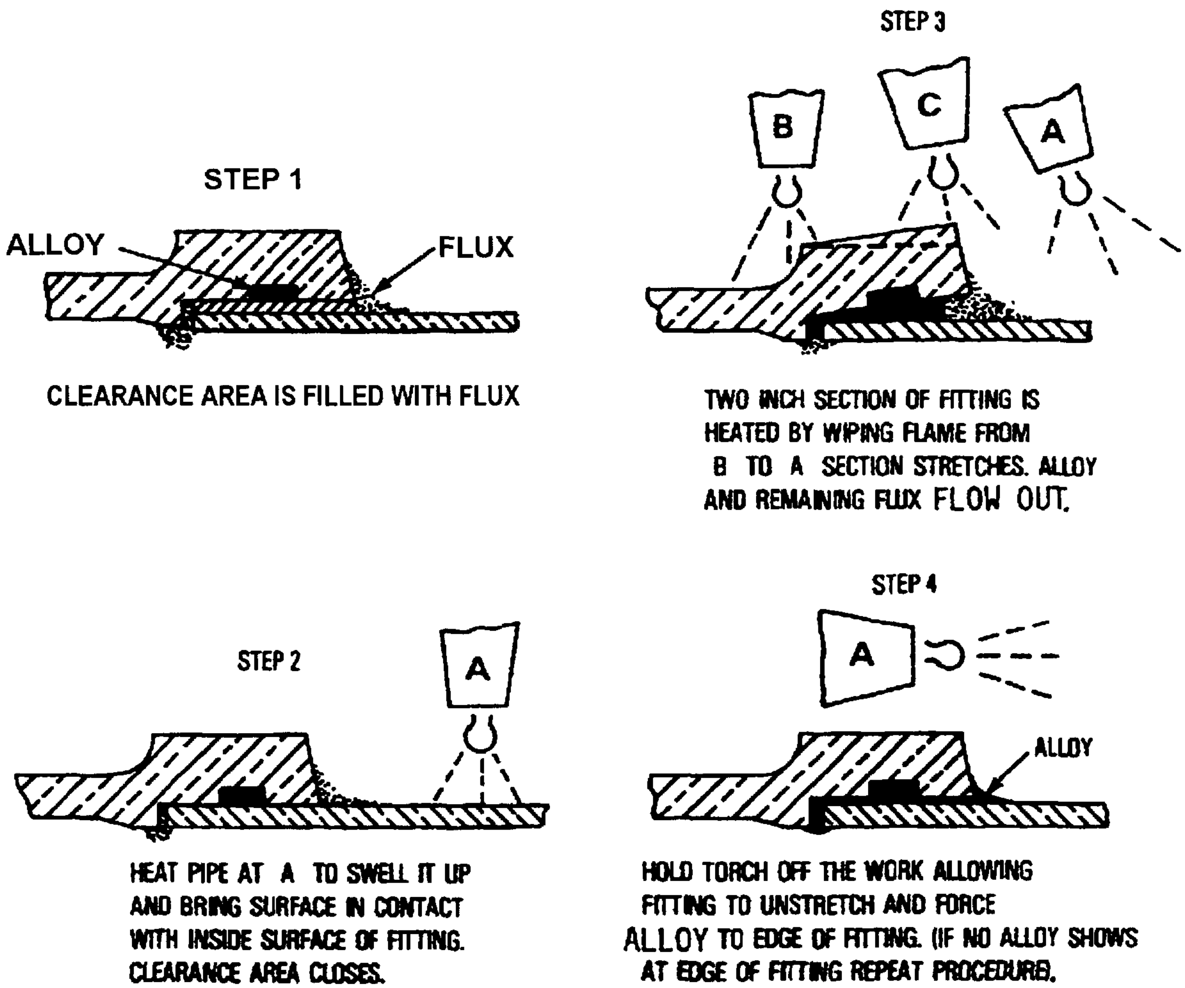


Figure 505-6-1. Alloy Insert Method of Silver Brazing Fitting to Tube

505-6.3.4.2.1 In the face-feed method the alloy always flows toward the point where heat is being applied. In this method the alloy is fed at the outer edge of the joint, while the flame is directed on the inner edge of the joint, as illustrated in step 3 of figure 505-6-2.

505-6.3.4.2.2 The heat required to melt the alloy passes through the parts to be joined to the point where the alloy is being applied. This method relies on the judgment of the operator to determine when both parts are properly heated, when to feed the alloy, and whether sufficient alloy has been fed into the joint to completely fill the space between the two parts being joined.

505-6.3.4.2.3 In the face-feed method, alloy visible at the edge of the joint does not necessarily indicate that the entire joint is filled with alloy.

505-6.3.4.2.4 NSTM Chapter 074, Volume 1, also contains information pertinent to silver-brazing pipe joints.

505-6.4 FLANGED JOINTS

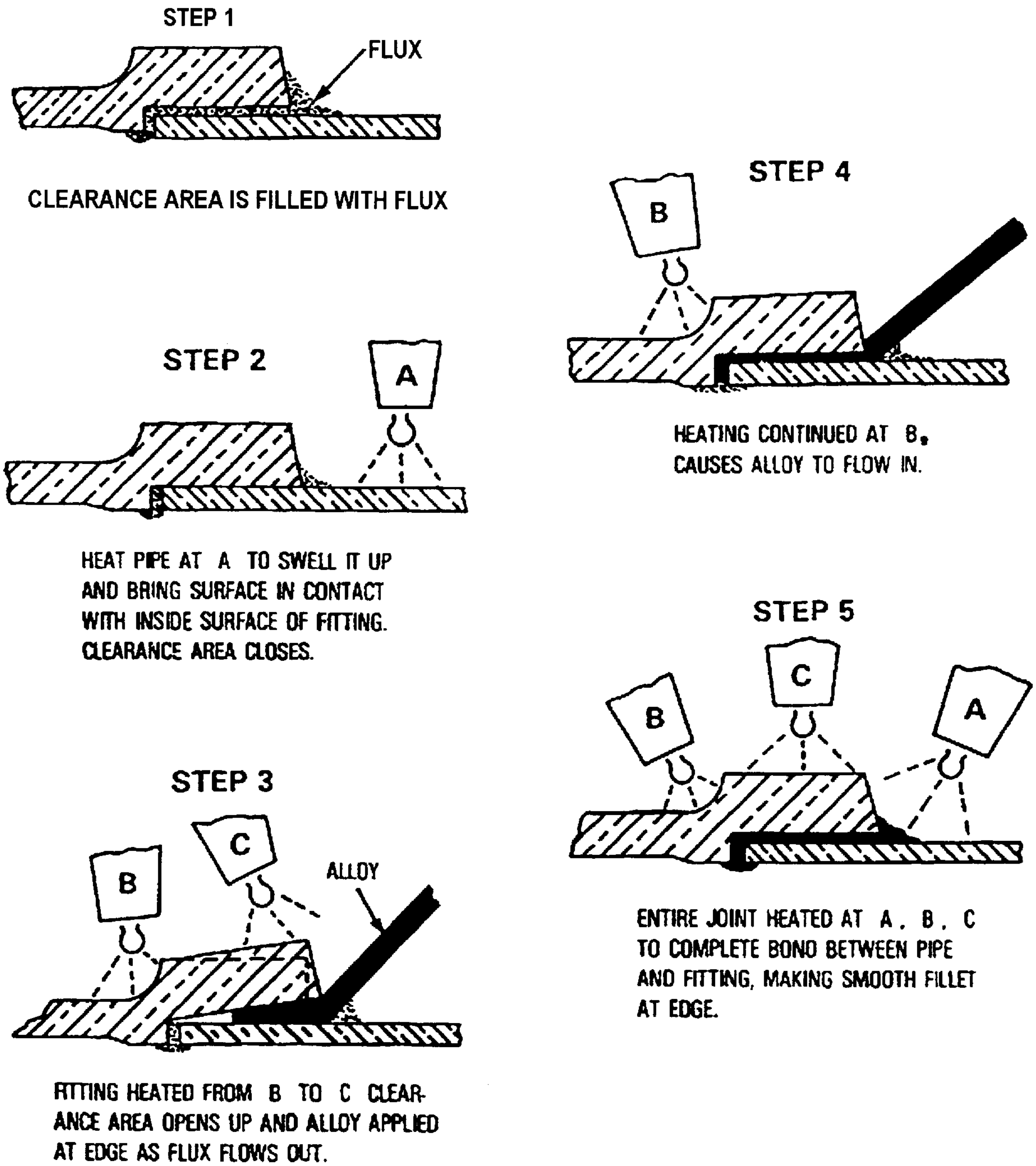


Figure 505-6-2. Face Feed Method of Silver-Brazing Fitting to Tube.

505-6.4.1 GENERAL. Flanges are installed in piping systems to ease removal and maintenance of piping and equipment. Flange requirements are specified in MIL-STD-777, **Schedule of Piping, Valves, Fittings and Associated Piping Components for Naval Surface Ships** and MIL-STD-438, **Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarine Service.** (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.) Flanges are typically joined to pipe and tube by welding. Detailed joining procedures are provided in MIL-STD-22.

505-6.4.2 FLANGE DESIGNS. Four flange designs are used in Navy piping systems; they are described in the following paragraphs.

505-6.4.2.1 Flat-Face Flanges. Flat-face flanges are commonly used in low-pressure, low-temperature applications. They are usually made from nonferrous materials and employ sheet type gaskets. In some application, such as submarine sea water system and sea water system components, O-rings are used.

505-6.4.2.2 Raised-Face Flanges. Raised-face flanges are commonly used in high-pressure, high-temperature applications. A raised-face flange is illustrated in figure 505-6-3. They are usually made from ferrous materials and employ spiral-wound gaskets. Flat face nonferrous flanges shall not be mated with raised-face steel flanges. Raised-face flanges are furnished in accordance with ANSI B16.5, which provides a range of pressure ratings for different temperatures and materials. As an example, a carbon steel class 1500 flange has a pressure rating much higher than 1500 psig at 200°F but much less than 1500 psig at 900°F. Refer to ANSI B16.5 for actual pressure ratings.

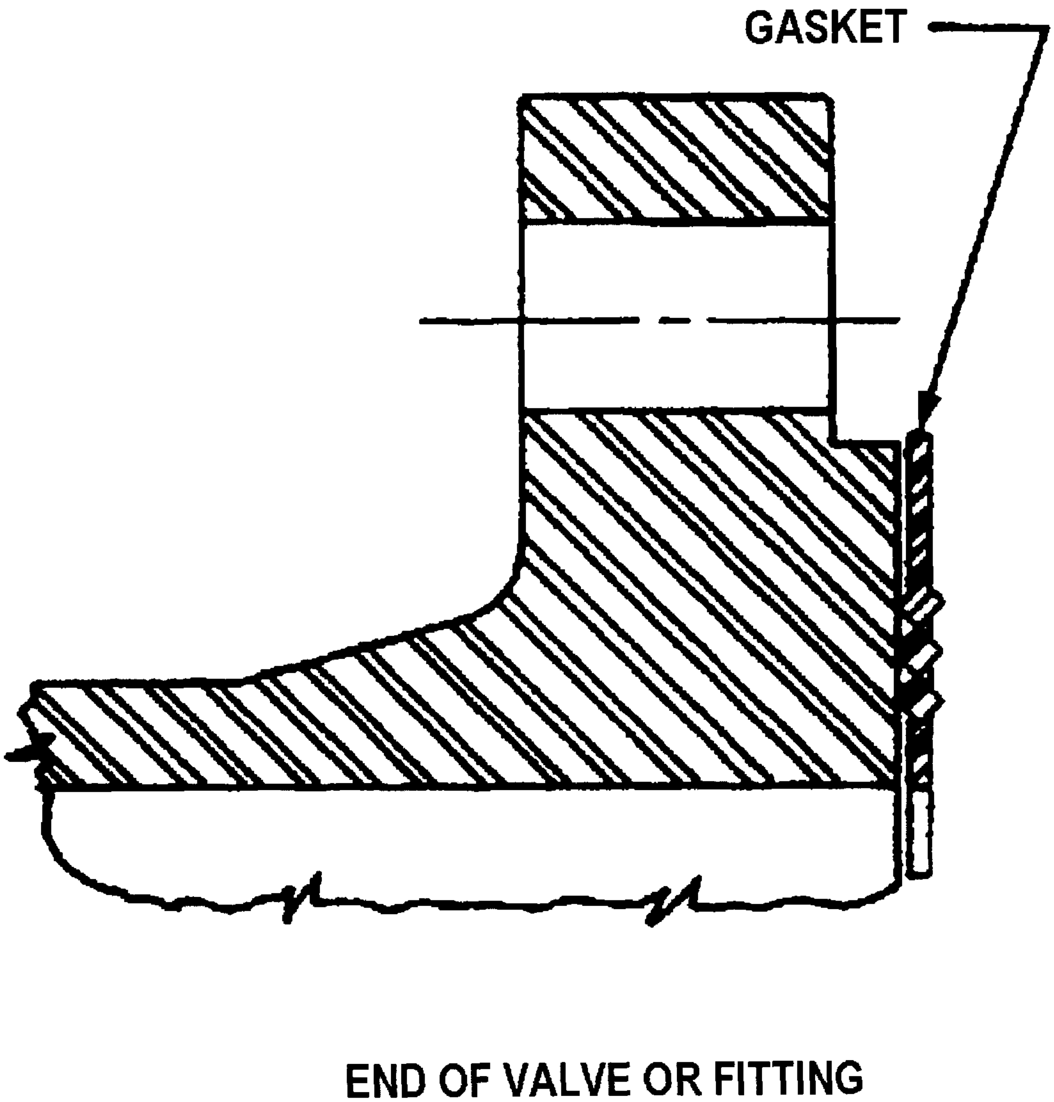


Figure 505-6-3. Raised Face Flange Gasket

505-6.4.2.3 Bulkhead/Deck Penetration Flanges. These flanges are used where piping passes through decks or watertight bulkheads. Their main purpose is to prevent flooding of adjacent spaces by sealing the hole cut in the bulkhead or deck for the piping to pass through. Many design configurations are currently in use. Rigid type penetrations are shown on NAVSEA DWG 803-1385866 and 810-1385899. When used in high-temperature systems, such as steam and diesel exhaust systems, insulating washers and ferrules are used on the flange fasteners to prevent the bulkhead from becoming hot and to prevent the piping system fluid from being cooled. See paragraph 505-6.8.1(f) for information on Elastic Strain Preload type bulkhead fittings.

505-6.4.2.4 Hydraulic Flanges. These flanges are used almost exclusively in submarine hydraulic systems. A hydraulic flange assembly is illustrated in figure 505-6-4. Replacement flanges can be ordered to MIL-F-24704 and associated specification sheets. On surface ships, 4-bolt split flanges in accordance with SAE J-518 are often used.

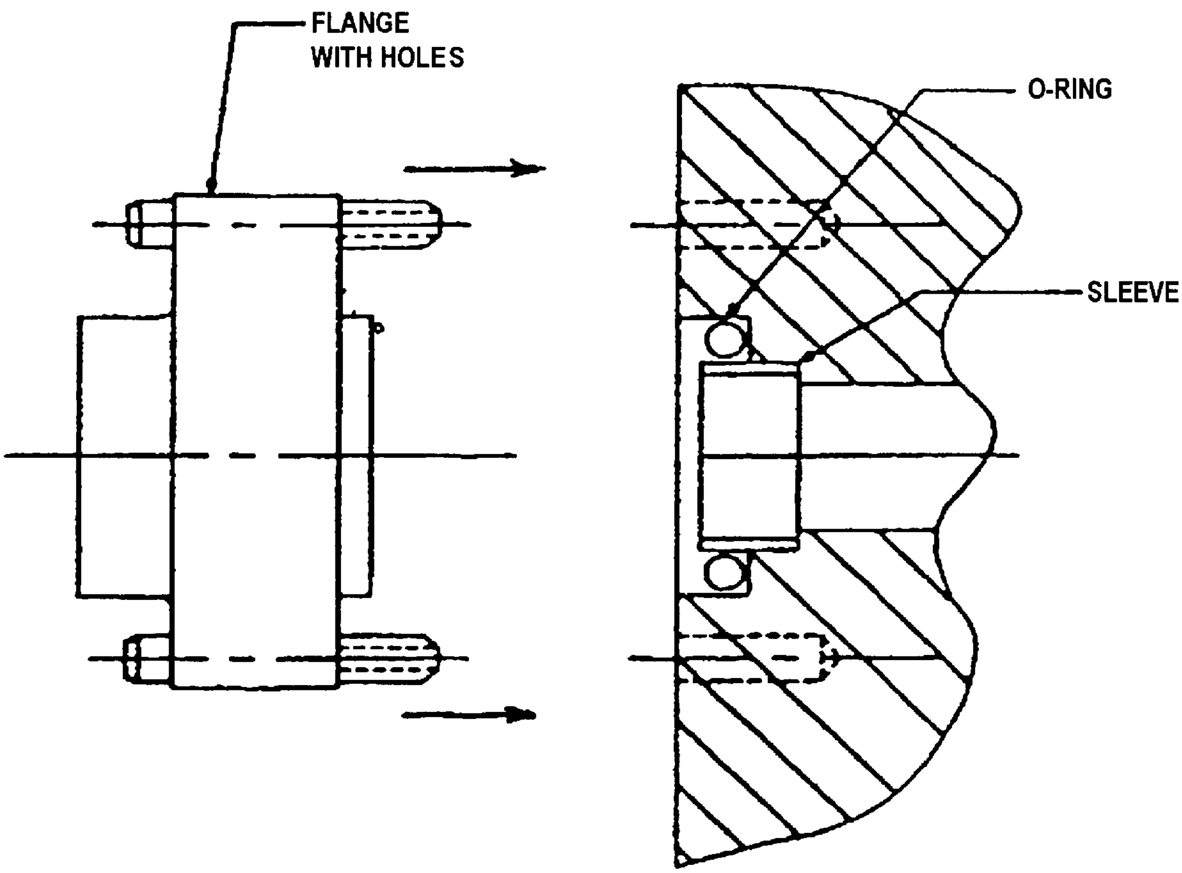


Figure 505-6-4. Hydraulic Piping System Flanges

505-6.4.3 FLANGE-FACE SURFACE FINISHES. The surface finish depends on the type of seal used in the joint. The three types of flange seals most commonly used are O-rings seals, flat gaskets, and spiral-wound gaskets. Consult NSTM Chapter 078, **Gaskets, Packings, and Seals** , for additional information regarding these seals. Surface finishes are commonly specified by a Roughness Average (Ra) Rating which is defined in ANSI B46.1. The information on surface finishes in paragraphs 505-6.4.3.1 through 505-6.4.3.3 is provided for guidance; these finishes do not supersede those specified in applicable documents.

505-6.4.3.1 Surface Finish for Use with O-ring Seals. A surface finish of 63 Ra maximum is required for all surfaces in an O-ring groove gland. A surface finish of 125 Ra maximum is specified for the flange face opposite to the O-ring groove. These requirements are consistent with SAE AS 4716, **Aerospace Standard, Gland Design, O-Ring and Other Elastomeric Seals.**

505-6.4.3.2 Surface Finish for Use with Flat Gaskets. A surface finish of 500 to 1000 Ra is required for circular lay finishes, while 125 to 500 Ra is required for spiral lay finishes produced by machining 30 to 80 serrations of uniform depth per inch of face width. On flanges having a nominal size greater than 12 inches, 21 to 80 serrations per inch of face width is permissible. These requirements are consistent with MIL-F-20042, **Flanges, Pipe and Bulkhead, Bronze (Silver Brazing).**

505-6.4.3.3 Surface Finish for Use with Spiral-Wound Gaskets. A surface finish of 125 to 250 Ra is required for circular or spiral lay finishes. Spiral lay finishes are produced by machining 45 to 55 grooves per inch of face width. These requirements are consistent with ASME B16.5.

505-6.4.3.3.1 In applications involving toxic or explosive fluids, a spiral lay finish having 24 to 80 grooves per inch and a surface finish of 125 Ra maximum is required. These requirements are consistent MIL-G-24716, **Gaskets Metallic-Flexible Graphite, Spiral Wound.**

505-6.4.3.4 Damaged Surface Finishes. Marks, grooves, or scratches which run from the inside to the outside of the flange sealing surfaces are potential leak paths. They should be removed prior to joint assembly.

505-6.5 GASKETS AND O-RINGS

505-6.5.1 GENERAL. Gaskets and O-rings form the seal between the mating surfaces in a clamped joint. A seal can also be formed by perfect contact between the mating surfaces, which can be achieved by lapping or polishing. However, these operations are costly and impractical except for unions where the contact area is extremely small. Consult ships drawings, MIL-STD-777, **Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships** , or MIL-STD-438, **Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service** , for selection of the appropriate gasket or O-ring. (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.) NSTM Chapter 078 also contains relevant information.

505-6.5.2 MATERIAL AND CONSTRUCTION.

505-6.5.2.1 O-Rings. As standard practice, except systems in nuclear powered ships covered by MIL-STD-767 or NAVSEAINST 9210.36, fluorocarbon rubber O-rings are recommended for most piping systems at temperatures to 400°F even though the initial installation identifies other material. See NSTM Chapter 078, Volume 1, Seals, for recommended and acceptable substitute O-ring materials for specific piping systems. This chapter also identifies O-ring standards, dimensions and National Stock Numbers. Information is also provided on back-up rings which are typically used to prevent O-ring extrusion at pressures over 1500 psi.

505-6.5.2.2 Flat Gaskets. Flat gaskets are typically made of following materials:

a. Synthetic rubber per MIL-G-1149, **Gasket Materials, Synthetic Rubber, 50 and 65 Durometer Hardness** and can be used at temperatures up to 250°F.

b. Fabric-reinforced rubber per HH-P-151, **Packing; Rubber Sheet, Cloth-Insert** and can be used at temperatures up to 250°F.

c. The flat gaskets of nonasbestos material are in accordance with MIL-G-24696, **Gasket, Sheet, Non asbestos** . These gaskets can be used in steam service up to 150 psi/425°F, water service up to 400 psi/300°F, lube oil system up to 150 psi/250°F and hydraulic or other petroleum based oil systems up to 600 psi/180°F.

505-6.5.2.2.1 Preformed gaskets may be obtained from the Navy supply system or cut from sheet stock. Gasket dimensions can be templated from the flanges the gasket will be installed between. This can be accomplished by placing the sheet stock over the flange face and marking the cutting limits with light blows from a hammer. Strike normal to the flange face to prevent damaging the flange. Gasket bolt clearance holes should be approximately 1/16 inch larger than the flange bolt clearance holes. The gasket inner diameter should be approximately 1/32 inch to 1/4 inch larger than the diameter of the flange flow passage.

505-6.5.2.3 Spiral-Wound Gaskets. A spiral-wound gasket assembly consists of a refill and a ring as illustrated in figure 505-6-5. The refill is a laminated assembly consisting of filler strips spirally wound with dovetail-shaped metal windings. The refill is retained on the ID of the ring. The ring is also referred to as a metal outer, centering, retaining, or a compression control ring.

505-6.5.2.3.1 MIL-G-24716 **(Gaskets Metallic-Flexible Graphite, Spiral Wound)** gaskets have a maximum rating of 2500 psi at 1050°F and are intended for use with ANSI B16.5 raised-face flanges. MIL-G-16265 **[Gasket, Metallic-Flexible Graphite and Metallic-Asbestos, Spiral Wound (For Navy Flanged Joints in Piping Systems)]** gaskets have a maximum rating of 600 psi at 875°F and are for use with Navy raised-face flanges to MIL-F-20670, **Flange, Pipe, Carbon Steel 150 P.S.I., W.S.P. (For Naval Shipboard Use)** . MIL-G-15342 **(Gaskets, Metallic Spiral Wound for Boilers)** gaskets have a maximum rating of 1275 psi at 950°F and are intended for use with boiler manhole covers and handhole plates.

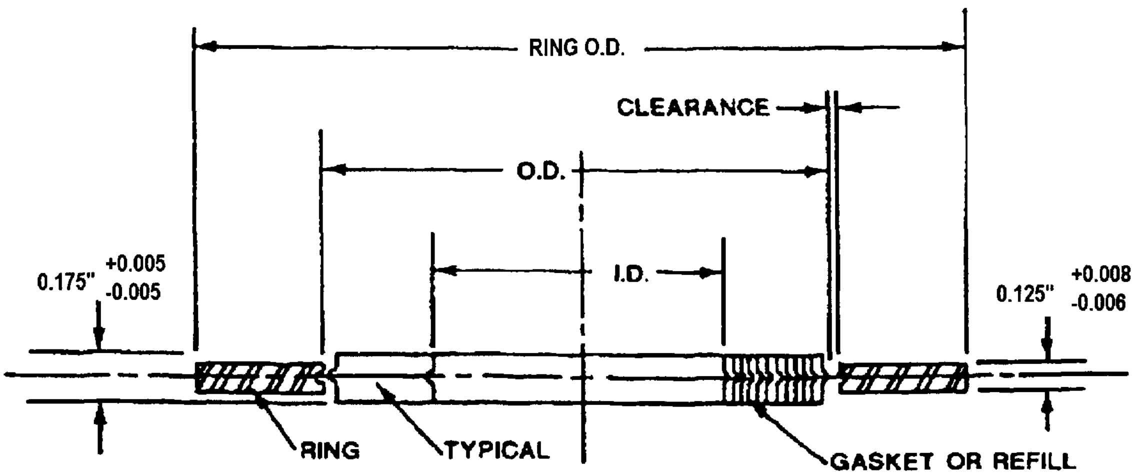


Figure 505-6-5. Spiral-Wound Metallic Gasket

505-6.5.2.3.2 Spiral-wound gasket assemblies (refill and ring) and refills are stocked in the Navy supply system. Refills shall be in accordance with the drawings specified in MIL-G-16265. It is recommended that only gasket assemblies be ordered. Although refills can be replaced, this practice is not recommended because the refill can be easily damaged during the procedure. Replace refills only when gasket assemblies cannot be obtained. When ordering replacements assemblies or refills be careful to note the required thickness and service temperature and pressure. Non-asbestos spiral-wound gaskets per MIL-G-24716, **Gaskets, Metallic - Flexible Graphite, Spiral Wound** , are approved for use in place of asbestos-filled gaskets. In general, a full-face gasket should not be used in raised-face flanges. The most commonly used gasket with raised-face flanges are spiral-wound gaskets. However, in some applications, a metal gasket, such as an annealed iron gasket, is used.

505-6.5.2.3.3 The refill thickness of the boiler manhole gasket has been standardized at 0.175, plus or minus 0.005 inch. In applications such as valve bonnets, handhole, and boiler manhole covers, a refill thickness of 0.125, plus or minus 0.005 inch, may be required.

505-6.5.3 GASKET AND O-RING INSTALLATION. Obtaining a leak tight seal is extremely dependent on installation procedures, specifically on properly compressing the gasket or O-ring and flange face alignment. Flange face alignment is addressed in paragraph 505-7.4. The design of O-ring glands and spiral-wound gaskets with retainer rings, automatically controls compression. However, the amount of compression applied to flat sheet type gaskets must be manually controlled.

505-6.5.3.1 Spiral-Wound Gasket Installation. Spiral-wound gaskets are commonly installed in high-temperature systems that are subject to thermal expansion. Cold springing is used to accommodate loads caused by thermal expansion. Cold springing is discussed in paragraph 505-7.3.

505-6.5.3.1.1 Assemble flanged joints containing spiral-wound gaskets in accordance with applicable system diagram or technical manual, or as follows:

a. Ensure fasteners, gaskets, and flange raised faces are free of burrs, nicks, dirt, and corrosion.

b. Lubricate fastener threads and nut bearing surfaces using lubricant permitted by applicable technical manual or drawings, 4or as approved by NAVSEA or its authorized representative.

WARNING

If during assembly, the onset of fastener yielding is noticed, discontinue further torquing. The onset of yielding is identified by a sudden decrease in the resistance of the fastener to the applied torque. Contact Engineering if yielding is noticed.

c. Ensure the raised faces of the flanges are parallel and as close together as practicable. Ensure all flange bolt holes are in alignment.

d. Position the gasket in the joint and assemble the bolts and nuts hand tight. Temporary pullup fasteners may be required at joints specified for cold pullup. These fasteners are longer but should be of the same diameter and material as those used at final assembly.

e. Tighten fasteners evenly in a star or cross pattern using a minimum of four passes. Obtain a total gap of between zero (metal-to-metal) and 0.010 inch between the flange raised faces and the gasket metal outer ring. For joints in permanent systems with a design pressure of 600 psi and above, attempt to obtain a total gap of 0.005 inch or less by one repetition of the tightening sequence. The gap is to be measured at four points 90 degrees apart with feeler gages. To the maximum extent practicable, flange raised faces should be maintained parallel during the tightening sequence. To ensure parallelism, the total gap should fall within a 0.005 inch range.

f. Check to be sure that no fasteners are loose. Confirm that any special torque requirements specified in technical manuals or drawings are met.

505-6.5.3.1.2 Additional guidance is provided in NAVSEA S9505-AM-GYD-010, **Submarine Fastening Criteria(Non-Nuclear)** .

505-6.5.3.2 Flat Gasket Installation. Compression of flat gaskets is usually controlled through fastener preloading. Consult ship drawings and equipment manuals or NSTM Chapter 078 for applicable fastener preloads. Although not common, compression can also be controlled by measuring the change in gasket thickness. To prevent excessive compressive set, do not compress gaskets more than 30 percent of their original thickness. This method should only be used when fastener preloads cannot be located.

505-6.5.3.2.1 When flanges in high-pressure applications are separated by a distance greater than the thickness of one gasket, use a spoolpiece and two gaskets of the specified thickness. Do not use a thicker gasket to make up the space.

505-6.5.3.3 Tightening Flange Fasteners. The tension in each joint fastener should be kept even as the flanges are drawn together. This helps to maintain flange face alignment as the joint is tightened which results in an even gasket compression and a tight seal. See NSTM Chapter 075 for detailed tightening procedures.

505-6.6 ASSEMBLY/DISASSEMBLY OF FLANGED JOINTS.

Flange fastener materials shall be per ship drawings or equipment manuals; MIL-STD-777 (for surface ships); MIL-STD-438 (for submarines); NSTM Chapter 075; or MIL-S-1222, **Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws and Nuts** ; in that order of preference. (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.)

505-6.6.1 ASSEMBLY OF BULKHEAD FLANGES. Insulate fasteners installed in bulkhead flanges located in steam or diesel exhaust systems as shown in figure 505-6-6. Consult ship drawings to identify insulating materials. The insulating material shall be capable of withstanding the compressive fastener load without crushing. The nonasbestos fiber gaskets, shown in figure 505-6-6, may be omitted if the insulating material is capable of forming a watertight seal.

CAUTION

Fasteners in surface ship steam systems with operating temperatures above 775°F are to be MIC Level I. Fasteners in submarines and nuclear-powered surface ship main steam, catapult steam, reboiler and feed systems with design pressures above 600 psig are to be MIC Level I. See NAVSEA 0948-LP-045-7010, Material Control Standard, Volume 1, for more details.

CAUTION

Ensure fasteners are of the proper material. Black oxide coated brass can be mistaken for steel.

505-6.6.2 ASSEMBLY OF STEAM AND FEEDWATER SYSTEM FLANGES. Verify the tightness of flange fasteners after the system's first thermal cycle.

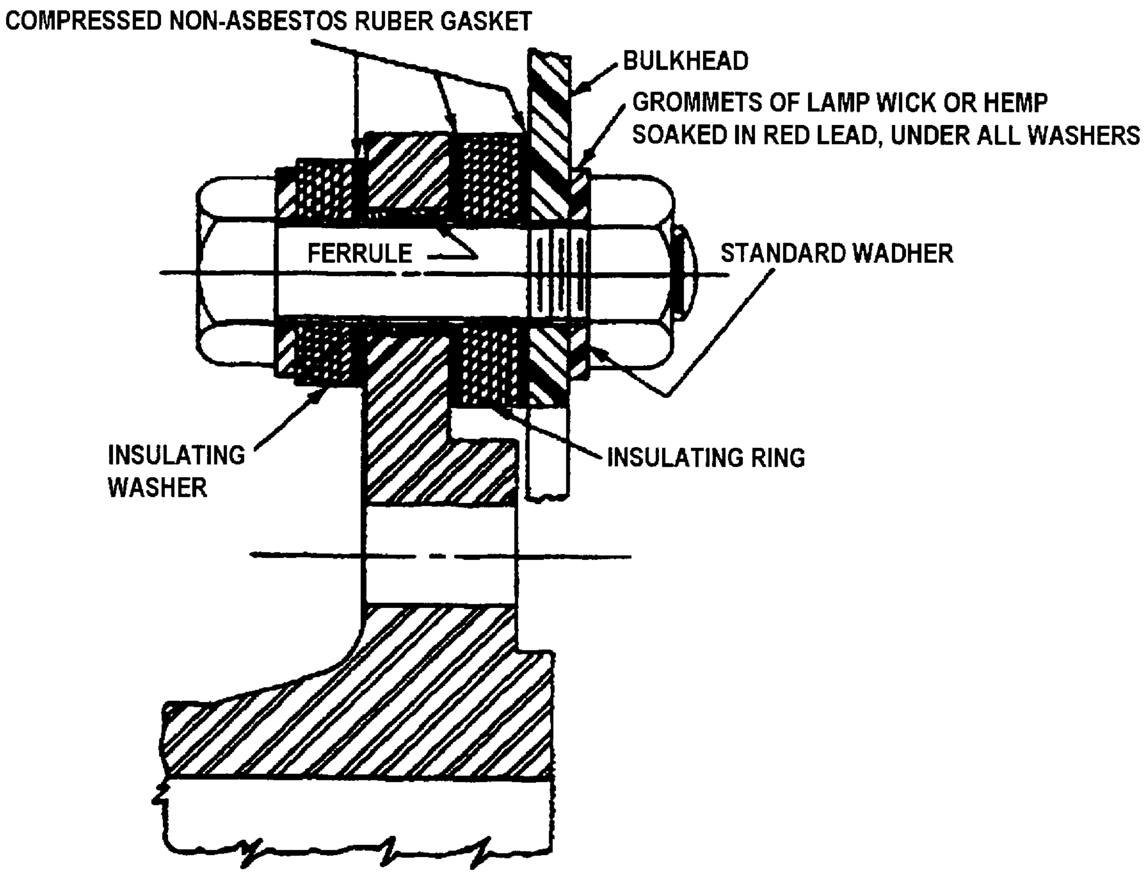


Figure 505-6-6. Bulkhead Flange

505-6.6.3 DISASSEMBLY OF HYDRAULIC FLANGES. Axial movement of the pipe or tube is required to separate hydraulic flanges. Hydraulic flanges typically have four fasteners and are almost exclusively installed in hydraulic systems.

505-6.6.4 FASTENER REPLACEMENT IN NONFERROUS FLANGES. When allowed by ship drawings or other NAVSEA approved documents, zinc and cadmium-plated steel fasteners in nonferrous piping systems that show signs of corrosion should be replaced with nickel-copper or nickel-copper-aluminum fasteners. See NSTM Chapter 075 for additional information on fasteners.

505-6.6.4.1 Corroded plated-steel fasteners are likely to be found where seawater, chilled water, firemain, and potable water piping passes through areas of high humidity, such as machinery spaces, sculleries, galleys, laundries, and heads. Moisture condenses on the fasteners and flanges promoting galvanic corrosion between the steel fasteners and nonferrous flanges.

505-6.6.5 DISASSEMBLY/ASSEMBLY PROCEDURES. The following procedures shall be used when disassembling or assembling flanged joints. These procedures do not supersede those specified on ship drawings or in equipment manuals.

a. Depressurize and isolate the system, or portion of system, in which the joint is located. See section 8 for detailed procedures.

b. Remove flange fasteners. Use of a ″bag and tag″ procedure, to ensure identification of the fasteners to that flanged joint, is recommended as good practice.

c. Remove and discard the gasket.

d. Clean all sealing and fastener bearing surfaces.

e. Visually inspect gasket-sealing surfaces for imperfections, especially for grooves or scratches that extend across the sealing surface. Reface or replace flanges if required.

f. Visually inspect fasteners for damage and corrosion. Ensure fasteners are the correct material and diameter.

g. Reassemble the flanged joint. Check alignment of the flange faces (see paragraph 505-7.4). Tighten the fasteners as specified on ships drawings or in equipment manuals. See NSTM Chapter 075 when guidance is not provided on drawings, or in technical manuals.

h. Repressurize the system and inspect the joint for leakage. If leakage is detected, verify fasteners are properly tightened. If leakage continues, disassemble the flanged joint and verify flange face alignment, the condition of the sealing surfaces, and that the proper gasket is installed.

505-6.6.5.1 If modifications to a piping system prevent flange closure on one gasket, use a suitable distance piece and use two gaskets. However, never use spacers with spiral-wound gaskets. Flange separation may be due to cold springing, (see paragraph 505-7.3).

505-6.7 THREADED CONNECTIONS

505-6.7.1 PIPE THREADED CONNECTIONS. Connections using tapered or straight pipe threads are susceptible to failure due to shock and vibration. Therefore, their use in critical piping systems is prohibited. They may be used in noncritical applications listed in MIL-STD-777, **Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships** , or MIL-STD-438, **Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service** . (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.) Due to the configuration of tapered threads, some form of sealant is often applied to prevent leakage. Polytetrafluorethylene (PTFE) tape is acceptable for use in sealing these threaded connections. This is the only approved application for PTFE tape. It may not be used on straight thread connections or where an O-ring or gasket is used.

505-6.7.2 UNIONS. Two types of union seals are in use. They are metal-to-metal and O-ring seals.

505-6.7.2.1 Metal-to-Metal Union Seals. MIL-F-1183 unions seal at the metal-to-metal contact between the thread piece and tail piece as illustrated in figure 505-6-7. The unions shown in MIL-F-1183, **Fittings, Pipe, Cast Bronze, Silver-Brazing, General Specification for** , are available with or without the O-ring and retainer ring. The O-ring unions are intended for all Navy applications, including condensate and other vacuum systems. Condensate systems on nuclear-powered ships and submarines require extra protection against contaminating fluids, such as bilge water, being drawn into the system by the below-atmospheric pressure inside the pipe. When metal-to-metal (ground joint) unions are used in these systems, an O-ring with a retaining ring is installed to provide extra protection. When installed, neither the O-ring nor the retainer ring are thick enough to prevent contact between the metallic sealing surfaces as illustrated in figure 505-6-7. Install only O-rings of the size shown in Table 505-6-1. Alternate integral O-rings/retainers are available in accordance with MIL-G-24748, **Gaskets, Metalic and Rubber, for use in Union Pipe Fittings 1/4 to 2-Inch NPS with various fluids from -30 °F (-34 °C) to 400 °F (204 °>C).**

505-6.7.2.2 O-Ring Union Seals. A union employing an O-ring face seal is illustrated in figure 505-6-8. The O-ring seal is energized by the union nut preload and system pressure.

505-6.7.2.3 O-Ring and Retainer Ring Materials. The following materials should be used:

1. O-rings - See NSTM CH-078 for recommended materials for specific piping systems and applicable NSN's.

2. Retainer rings - Bronze, in accordance with ASTM B61, **Copper Alloy Castings** alloy 903 or 922.

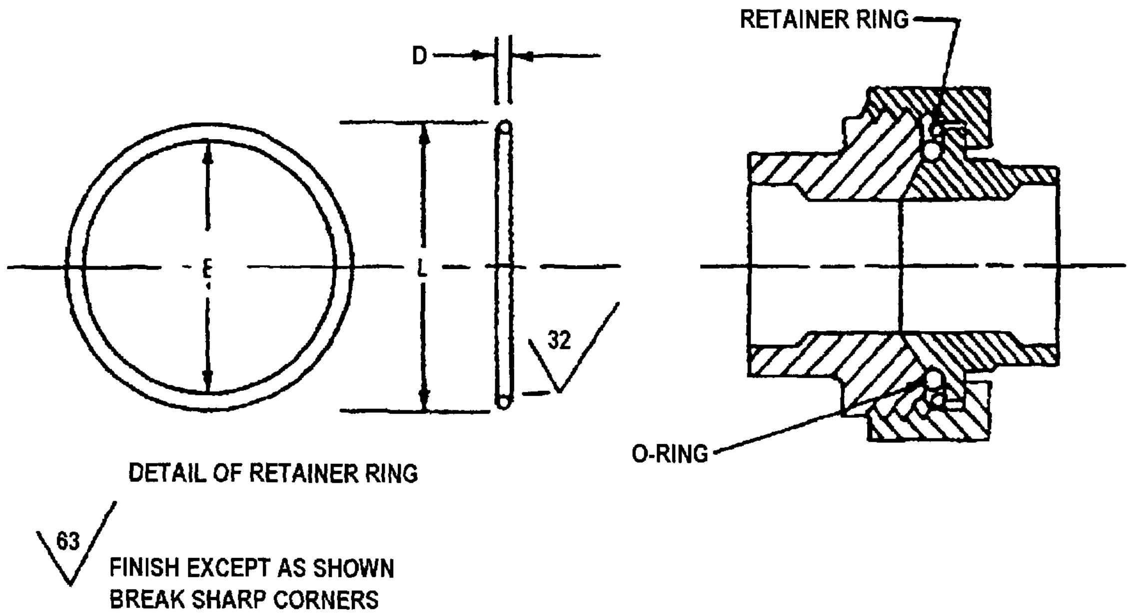


Figure 505-6-7. Unions with Retainer Ring and O-Ring

Table 505-6-1. O-RING AND RETAINER RING DIMENSIONS

Nominal Size	Retainer Ring		O-Ring	Uniform Dash No. AS 568
	D (Thickness +0.005)	E (ID +0.005)	L (OD +0.005)	
1/4	0.050	0.813	1.008	-017
3/8	0.050	0.938	1.184	-019
1/2	0.050	1.188	1.394	-023
3/4	0.060	1.500	1.715	-125
1	0.070	1.750	2.045	-129
1-1/4	0.070	2.062	2.471	-134
1-1/2	0.070	2.375	2.791	-139
2	0.090	3.000	3.391	-232

505-6.7.2.4 Preloading Union Nuts. Union nuts must be properly preloaded to ensure a leaktight seal is formed. Consult NAVSEA S9505-AM-GYD-010, **Submarine Fastening Criteria (Non-Nuclear)** , for torque preloads and procedures to be applied to both metal-to-metal and O-ring seal-type union nuts. The resulting axial loads ensure that the thread piece and tail piece remain in contact under all loading conditions. Contact between these surfaces must be maintained in unions employing metal-to-metal seals to prevent leakage, and in unions employing O-ring seals to prevent O-ring extrusion. Extrusion damages the O-ring and leads to leakage.

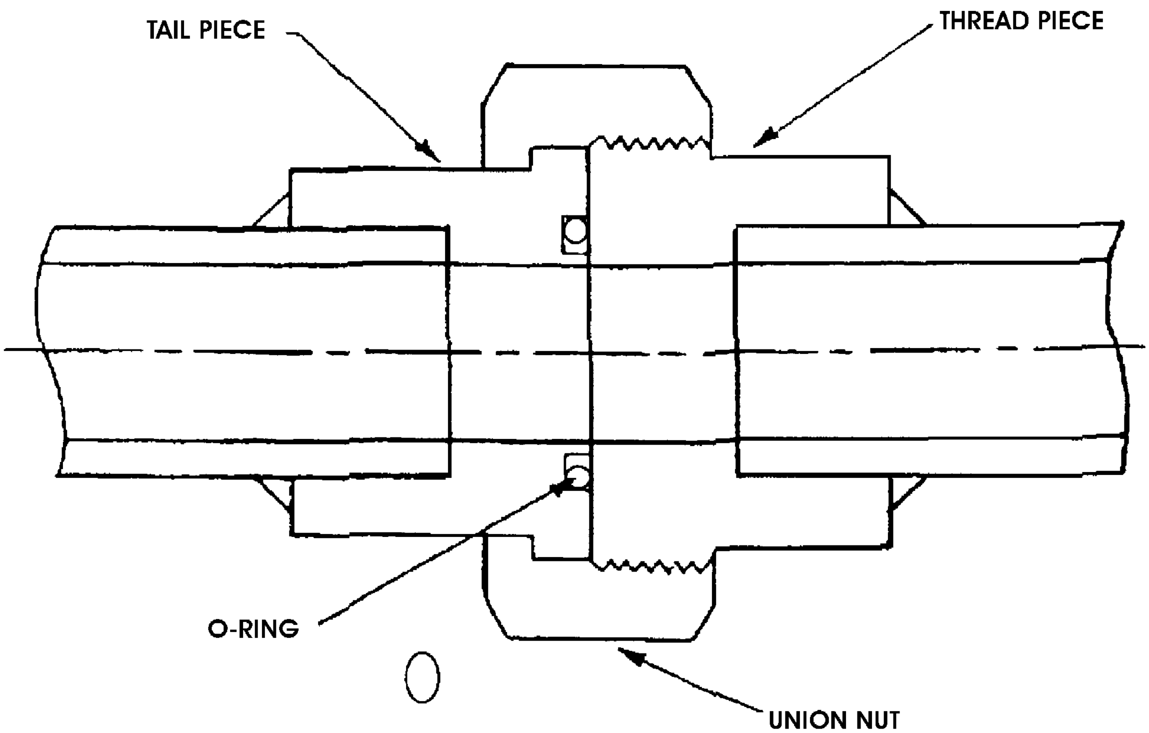


Figure 505-6-8. Flat-Face O-Ring Union

505-6.7.2.5 Union Disassembly/Assembly Procedures.

a. Depressurize and isolate the system, or portion of system, in which the union is located. See section 8 for detailed procedures.

b. Remove union nut (Ensure a counter-torque is applied to the piping adjacent to the union wherever MAFs (see 505-6.8) may be affected by the torque applied to the union nut).

c. Remove and discard O-ring.

d. Clean all metal sealing surfaces and the thread piece and nut threads.

e. Visually inspect sealing surfaces for imperfections, especially for grooves or scratches that extend across the sealing surfaces. Reface or replace as required.

f. Visually inspect thread piece and nut threads. Repair or replace as necessary.

g. Check alignment of thread- and tail-piece faces as specified in NAVSEA S9505-AM-GYD-010, **Submarine Fastening Criteria (Non-Nuclear).**

h. Replace the O-ring. Bend the new O-ring in half (do not crimp) and inspect the stretched surface for cracks, tear or other defects. If a defect is found, discard the new O-ring and obtain a replacement. Lubricate the thread- and tail-piece threads. Consult NSTM Chapter 262, **Lubricating Oils, Greases, Hydraulic Fluids and Lubricating Systems** , for lubricants approved for use in high-pressure compressed gas systems. Consult NSTM Chapter 556, **Hydraulic Equipment Power Transmission and Control** , for lubricants approved for use in hydraulic systems. For other systems, refer to NSTM Chapter 075, **Threaded Fasteners** , table 075-4, which lists lubricants for threaded fasteners. Tighten the union nut as specified in paragraph 505-6.7.2.4 (proper lubrication is essential to help prevent galling of the threads).

i. Repressurize the system and inspect the union for leakage. If leakage is detected, verify the union nut is properly tightened. If leakage continues, depressurize and disassemble the union joint and verify thread and tail-piece face alignment, the condition of the O-ring and sealing surfaces, and that the proper size and durometer O-ring is installed.

505-6.7.2.5.1 Special Union-End Ball Valves. The configuration of this assembly is illustrated in figure 505-6-9. In addition to the procedures specified in paragraph 505-6.7.2.5, check that the following conditions exist when assembling these valves.

a. Ensure that the perpendicularity between the internal insert threads and insert face does not exceed 0.002 inch.

b. Ensure that the insert face standout from the valve body thread piece is between 1/64 and 1/16 inch. If the standout is less than specified, the O-ring compression may be inadequate to ensure a tight seal. If the standout is more than specified, full engagement between the nut and valve body thread piece thread may not occur, which reduces the joint strength.

c. Remove any burrs from the insert. Special attention should be given to the sealing surface and wrench slots.

505-6.8 MECHANICALLY ATTACHED FITTINGS (MAFs)

505-6.8.1 GENERAL. Fittings utilizing mechanical means of attachment to piping (for example, crimping, ring locking, heat shrinking) are available from commercial suppliers, in accordance with ASTM F-1387, **Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings** . Specific MAF types that are already considered approved for shipboard use in accordance with ASTM F-1387 are listed below. Specific shipboard application requirements are as specified in the associated Uniform Industrial Process Instruction (UIPI) and/or specification, as applicable, for that fitting type (see below). Except for training purposes, there are no joint record requirements for currently approved MAFs. Design parameters and procurement and administrative procedures, applicable to all MAF types, are cited herein. Approvals are, in general, limited to fittings 2-1/2 NPS and below.

a. Axially Swaged Fittings (ASTM F-1387, Type VI); Category I UIPI 0505-452, latest revision; Fittings, Elastic Strain Preload (ESP), Lokring, Shipboard Installation Procedure

b. Radially Swaged Fittings (ASTM F-1387 Type I); Category I UIPI 0505-901, latest revision; Swage Marine Fitting (SMF) Shipboard Installation

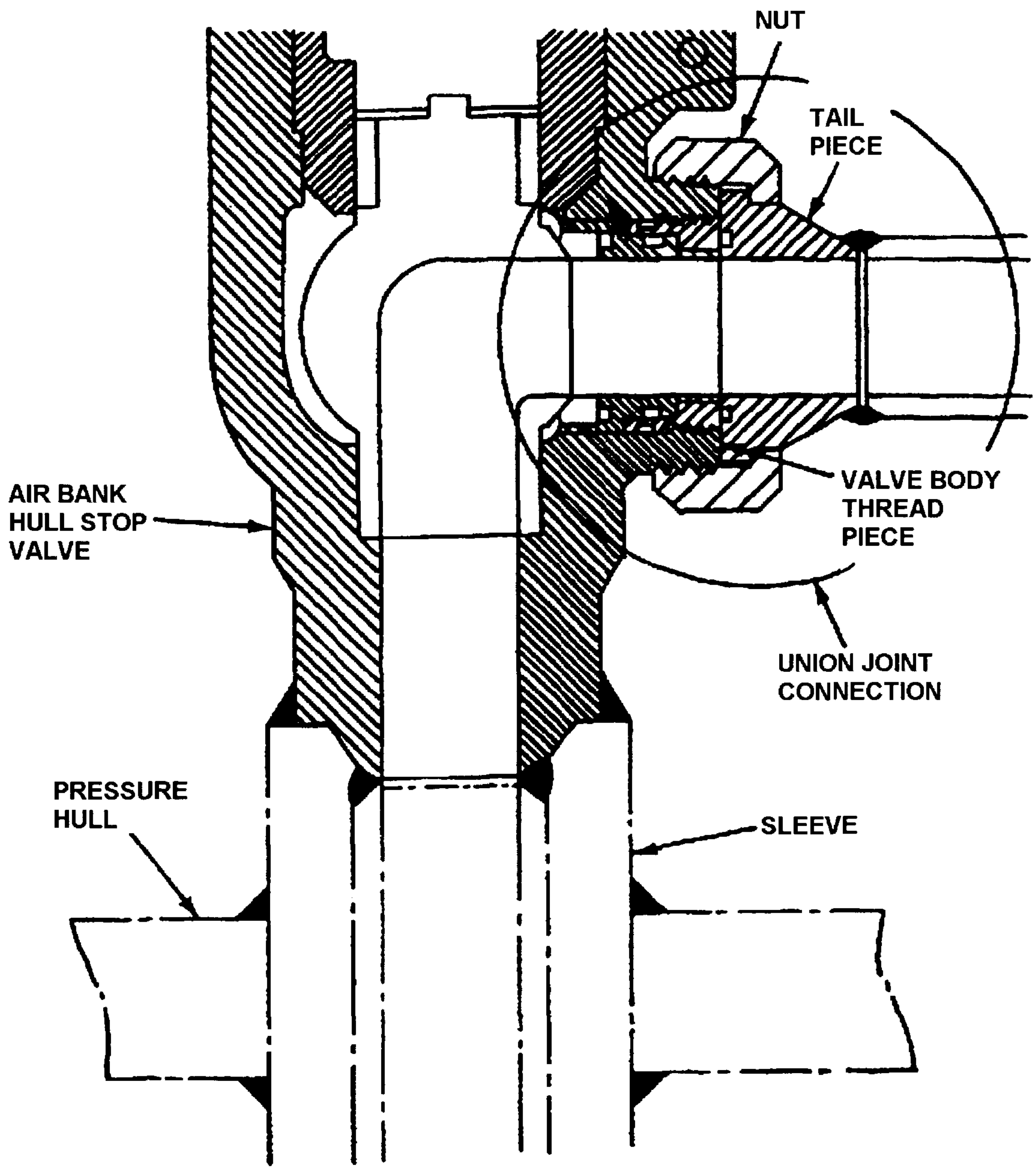


Figure 505-6-9. High-Pressure Air Bank Stop Valve Union Connection

c. Shape Memory Alloy (SMA) Couplings [ASTM F-1387, Type V - also known as Heat Recoverable Couplings (HRC) and HRC/Heat To Shrink (HTS) Couplings]; Norfolk Naval Shipyard Process Instruction 0056-468, latest revision; Heat Recoverable Coupling (HRC) Installation and Inspection; MIL-C-24706, **Coupling, Pipe, Heat-Recoverable.**

d. Axially Swaged Fittings (ASTM F-1387, Type VI) Category I, UIPI 0505-911, Rev (latest), Axially Swaged Mechanically Attached Fittings (Deutschlok), Shipboard Installation Procedure.

e. Grip Type Fittings (ASTM F-1387, Type IV), UIPI (later).

f. Carbon steel Elastic Strain Preload (ESP) bulkhead fittings that are similar to MAFs, Lokring Corp, P/N series and Lokring drawings CS-BHP1-PXX or CS-BHP2-PXX, may be used as an alternative to the plain sleeves shown on drawing, NAVSEA 803-1385866 for sizes 2 NPS and below. Bulkhead fitting ESP's shall be installed in accordance with the ESP Uniform Industrial Process Instruction (UIPI), except that piping passing through the fitting shall be continuous (not used for joining piping as with true MAFs) and shall not be used in wet sea water areas such as bilges and tanks.

NOTE

The information herein and in the above documents is intended to supersede all NAVSEA MAF approval letters up to 1 November 2001. Conflicts shall be directed to Life Cycle Manager (Puget Sound Naval Shipyard Code 260.5LCM) for resolution. Future approvals shall initiate change notices to this document.

NOTE

Manufacturers' instructions, approved by NAVSEA, shall be used for installation purposes if up-to-date instructions for any MAF are not included in the applicable UIPI.

NOTE

Puget Sound Naval Shipyard Code 260.5LCM shall be sent a copy of any parametrics (see ASTM F-1387) used for testing certification, as well as details of new MAF approvals for inclusion herein.

505-6.8.1.1 Advantages. Some of the advantages MAFs have over welded and brazed fittings are as follows:

a. No fire watch or hot work required

b. Short installation time

c. Lower installed cost

d. Normally one-piece design

e. Significantly reduces or eliminates flushing.

505-6.8.1.2 Restrictions.

a. Surface Ships Only: Only ESP and axially swaged type MAFs may be used in machinery spaces of nuclear surface ships on non-nuclear systems; and in nuclear systems as authorized in NAVSEA 0989-043-0000. Other types of MAFs shall not be used inside the machinery space, or in nuclear piping regardless of location, on board nuclear surface ships unless specifically approved by NAVSEA. MAFs shall not be used in Level I applications. Fire hardened fitting qualifications (see paragraphs 505-7.9.1.3 and 505-7.9.2.1) are indicated in Tables 505-6-2 through 505-6-5.

b. Submarines Only: Only ESP and axially swaged type MAFs approved for fire hazardous applications may be used on unpressurized submarine systems, and in nuclear systems as authorized by NAVSEA 0989-37-2000. Other types of MAFs shall not be used on board submarines unless specifically approved by NAVSEA.

505-6.8.1.3 Dimensions. Overall dimensions of MAFs shall be in accordance with the manufacturers' specifications for those fitting part numbers listed herein and in UIPIs, or approved to ASTM F-1387, in the future. Dimensions of various MAF types and classes may not be the same and should be determined for system design purposes. Dimensions of fitting bodies (i.e., without attachment ends) should be similar to Navy or Navy adopted commercial standards (e.g., NAVSHIPS drawing 810-1385880, ANSI B16.11).

505-6.8.1.4 Seal Welding Restriction. Seal welding of MAFs has not been proven and should not be done under normal operating/installation procedures.

505-6.8.1.5 Substitution. MAFs may be substituted for welded or brazed fittings wherever welded or brazed fittings are specified in drawings/specifications, subject to the conditions and restrictions herein and in referenced documents.

505-6.8.2 TRAINING. Use of any of the several types of MAFs addressed herein in any shipboard piping system is contingent upon the satisfactory completion by the installer of an approved training program. A training program shall be developed by the installing activity which satisfies the requirements specified herein for each type of fitting planned or scheduled for installation. The program(s), in the form of Process Control Procedures for private facilities, shall be approved by NAVSEA or responsible Navy activity prior to implementation; one time approval is required, unless the procedure has been changed. The installer's schedule shall allow for written certification of satisfactory completion of the applicable training program(s) prior to the installation of any fitting(s). The training program for each type of fitting shall, as a minimum, include safety; quality control; fitting selection; use of protective coating; and installation preparation, methods, procedures, and techniques. Each program shall be based on the most current version/edition of the applicable fitting manufacturer's procedures, and any process instruction identified herein.

505-6.8.3 PROCUREMENT. Procuring activities must specify that all supplements to ASTM F-1387 are required for Navy shipboard applications when testing new MAF designs. The Fire Test, however, is not required if the fittings are not to be used in fire hazardous applications listed in each UIPI.

505-6.8.4 ADMINISTRATION. The MAFs specified herein reflect a summary of all MAF approval letters dated prior to 1 November 2001. However, **types** and, in some cases, **trade names** (e.g., HRC) specified in those approval letters have been replaced herein by ASTM F-1387 terminology (e.g., Type I HRC in NAVSEA approval letters is now Type V, Shape Memory Alloy, Grade F, Class 10 MAF). UIPIs may address most but not all MAF designs approved by NAVSEA to date.

505-6.8.4.1 The UIPIs may specify some manufacturers' part numbers and NSNs. This data is for information only and not meant to indicate preference for one MAF over another.

505-6.8.4.2 Tables 505-6-2 through 505-6-5 are for reference only and shall not be used for procurement, design, or installation purposes. Check the applicable UIPI for official and more detailed information.

505-6.8.5 FLARELESS BITE-TYPE FITTINGS.

505-6.8.5.1 General. Flareless mechanical bite-type fittings, shown and described in this chapter, are intended for use only where such fittings are allowed by applicable ship drawings. These fittings are according to MIL-F-18866, **Fittings, Hydraulic Tube, Fluid, 37 Degree and Flareless, Steel** or ASTM F 1387, Type III.

NOTE

NAVSEA policy is to reduce or eliminate use of flareless fittings in new design ships; the extent to which flareless fittings are approved for use in a particular ship is reflected in the applicable ship drawings.

Table 505-6-2. GENERAL AXIALLY SWAGED MAF APPROVAL CHART (REFERENCE ONLY)

ASTM F-1387		Fitting				Pipe			Remarks
Type	Class/ Grade	Pressure Max.	Temperature °F	Part Number	Material	Sizes	Material	Wall Thickness	Qualifications
VI Note 1	1D	250	-60 to 425	CN-200-XXX-PXX (Lokring Corp.)	90/10 Copper nickel	1/4 to 2 NPS	90/10 Copper nickel (MIL-T-16420)	Class 200 and Class 200 Special	Approved for fire hardened fitting applications
							Copper (MIL-T-24107)	0.065″	
	8D	3300		CN-3300-XXXPXX (Lokring Corp.)	70/30 Copper-Nickel	1/4″ OD Note 5	70/30 Copper-nickel (MIL-T-16420)	.035″ to .058″	
	8B	3300	-60 to 500 Note 2	SS-3300-XXXPXX (Lokring Corp.)	316L SS	1/4 to 1-1/2 NPS Note 3	Seamless carbon steel (MIL-P-24691/1, ASTM A106)	Schedule 80, 40, and 10	Approved for fire hardened fitting applications except on schedule 10 carbon steel pipe.
							Seamless stainless steel (MIL-P-24691/3, ASTM A312)		
						1/4″ OD to 3/4″ OD Note 5	Seamless stainless steel (MIL-P-24691/3, ASTM A312 & MIL-T-8606)	.035″ to .065″	Approved for fire hardened fitting applications
	3D/B	700	-65 to 450	DKN_(Deutsch Metal Components)	70/30 Copper nickel with 304 SS swage ring	1/4 to 2 NPS	70/30 Copper nickel (MIL-T-16420)	Class 700	Approved for fire hardened fitting applications. Note 4
		250					90/10 and 70/30 copper nickel (MIL-T-16420)	Class 200	
		300					Copper (MIL-T-24107)	0.065″ to 0.083″	

Table 505-6-2. GENERAL AXIALLY SWAGED MAF APPROVAL CHART (REFERENCE ONLY) -

Continued

ASTM F-1387		Fitting				Pipe			Remarks
Type	Class/ Grade	Pressure Max.	Temperature °F	Part Number	Material	Sizes	Material	Wall Thick-ness	Qualifications
VI Note 1 (Cont.)	10D	6000	-65 to 500	DPL CL1 B04 (Deutsch Metal Components)	70/30 Copper nickel w/316/ 316L SS swage ring	1/4″ OD	70/30 Copper nickel (MIL-T-16420)	.035″ to.058″	Approved for fire hardened fitting applications. Note 4
	10B			DPL CL1 K04 (Deutsch Metal Components)	316/316 L SS w/13/8 PH swage ring		Stainless Steel (MIL-P-24691/3 & ASTM A106 GR B)	.028″ to.049″	Approved for fire hardened fitting applications.

NOTES:

1. Type VI was formerly designated as ″ESP MAF″.
2. These fittings may also be used for non-Level I steam systems up to 600 degrees F at a maximum pressure of 1500 PSIG.
3. These stainless steel 1-1/4 and 1-1/2 NPS fittings shall not be used in systems where 100,000 or more cycles of pressure variation of more than 2/3 normal operating pressure are expected.
4. Not permitted in areas where they will normally be submerged in seawater, such as bilge areas or tanks.
5. Not permitted in machinery spaces of nuclear ships.

Table 505-6-3. GENERAL RADIALLY SWAGED MAF APPROVAL CHART. (REFERENCE ONLY)

ASTM F-1387		Fitting				Pipe			Remarks
Type	**Class/ Grade**	**Pressure Max.**	**Temperature °F**	**Part Number** Note 3	**Material**	**Sizes**	**Material**	**Wall Thickness**	**Qualifications**
I Note 1	8B	3750	-60 to 400	DM20_K_	Stainless steel	1/4 - 1-1/2 NPS	Stainless steel or carbon steel	Schedule 10, 40, 80	Braze equivalent only. Not approved for fire hardened fitting applications.
				DM60_K_ Note 2		1/4″ - 1-1/2″ OD		.025 - .207	
	8D			DM20_B_	Copper nickel	1/4 - 1 NPS	Copper nickel or copper	Class 200-3300 on CUNI (1/4″ OD up to class 6000)	
				DM60_B_		1/4″ - 1″ OD		Up to 3750 psi on copper	
	1; 3D	250		DLPN_		1/4 - 2-1/2 NPS	Copper nickel	Class 200 and class 200 special	
		600					Copper	Up to 600 psi	

Notes:

1. Type I was formerly designated as ″swaged MAF″, also known as swaged marine fitting (SMF).
2. Permitted on 1/4″ OD 6000 psi copper nickel alloy instrument tubing for non-seawater systems.
3. All part numbers are from Deutsch Metal Components.

Table 505-6-4. GENERAL SHAPE MEMORY ALLOY MAF APPROVAL CHART. (REFERENCE ONLY)

ASTM F-1387		Fitting				Pipe			Remarks
Type	**Class/ Grade**	**Pressure Max.**	**Temperature °F**	**Part Number** Note 2	**Material**	**Sizes** Note 1	**Material**	**Wall Thick- ness**	**Qualifications** Note 3
V	10F	6000	-65 to 575	920582- X.XXX	SMA (Ni- Ti)	1/8 - 1-1/2 NPS	CRES	.068 - .281	MIL-C-24706(SH). May not be used for fire hardened fit- ting applications wherever Type VI fittings are approved for this purpose. Also may not be used in seawater systems.
							Carbon Steel	.068 - .200	
							70/30 CUNI	.042 - .425	
						1/4″ - 1-1/2″ OD	70/30 CUNI	.035 - .340	
							CRES	.035 - .250	
							Carbon Steel	.035 - .200	
	10D/F	6000	-65 to 575	920911- X.XXX	SMA (Ni-Ti) w/CUNI liner	1/4 - 1 NPS	70/30 CUNI	.065 - .300	MIL-C-24706(SH). May not be used for fire hardened fit- ting applications wherever Type VI fittings are approved for this purpose.
							90/10 CUNI	.065	
							Copper	.065 - .340	
						1/4″ OD	70/30 CUNI	.035 - .058	
							90/10 CUNI	.035 - .065	
							Copper	.032 - .065	
	10F	6000	-65 to 575	920426 - .250	SMA (Ni-Ti) HTS	1/4″ OD	CRES	.035 - .065	Not approved for fire hard- ened fitting applications.
							70/30 CUNI	.035 - .058	
							90/10 CUNI	.035 - .065	
							Copper	.032 - .065	

Notes:

1. 1/4″ OD sizes (all classes) are permitted in instrumentation per NAVSHIPS Dwg. 803-1385850; subject to the restrictions herein for that class.
2. All part numbers are from Advanced Metal Components, Inc (AMCI).
3. SMAs installed in locations where the external surfaces of the coupling could be exposed to seawater, such as in splash zones, bilge areas, sprinkler systems, and on weather decks shall be provided with complete (100 percent) external surface protection through the application of an approved protective coating, such as paint, in accordance with Mil. Spec. MIL-P-24441, or a sleeve/tape of heat-shrinkable thermoplastic. The protective coating shall be applied following satisfactory completion of the required hydrostatic testing of the joints.

Table 505-6-5. GENERAL GRIP TYPE MAF APPROVAL CHART. (REFERENCE ONLY)

ASTM F-1387		Fitting				Pipe			Remarks
Type	**Class/ Grade**	**Pressure Max.**	**Temperature °F**	**Part Number**	**Material**	**Sizes**	**Material**	**Wall Thick- ness**	**Qualifications**
IV	8B	3750	-65 to 1000	SS-XXX- (Swagelok)	316 SS	1/4″ OD to 1/2″ OD	Stainless Steel (MIL-P-24691/3, ASTM A213, ASTM A269 & MIL-T-8606	.035″ to .109″	Braze equivalent only. Not approved for fire hardened fit- ting applications.
				SS-XXXX- (Swagelok)	316 SS	1/4″ OD to 1″ OD	Stainless Steel (MIL-P-24691/3, ASTM A213, ASTM A269 & MIL-T-8606		Approved for fire hardened fit- ting applications.

505-6.8.5.1.1 Where such fittings are used, the following criteria applies:

1. Sufficient space shall exist for proper tightening of nuts without removal of any other equipment or piping for access.
2. The tubing being joined shall be easily deflectable for assembly or disassembly of the joint.
3. Where used for connection to equipment, fittings shall have straight threads with O-ring seals for boss mounting, except that fittings for 1/2-inch OD and below may have Dryseal tapered pipe threads on one end for applications where tapered pipe threads are not otherwise prohibited.
4. Backup washers shall be used on adjustable O-ring fittings.
5. The first tube bend or other obstruction to movement of the fitting nut shall be far enough from the ferrule to permit exposing at least 1/8 inch of the tubing on the nut side of the installed ferrule. Figure 505-6-10 shows a ferrule positioned on its tube for presetting.

505-6.8.5.1.2 Selection of fittings shall be according to table 505-6-6. Use only those materials permitted by ship drawings for the specific application.

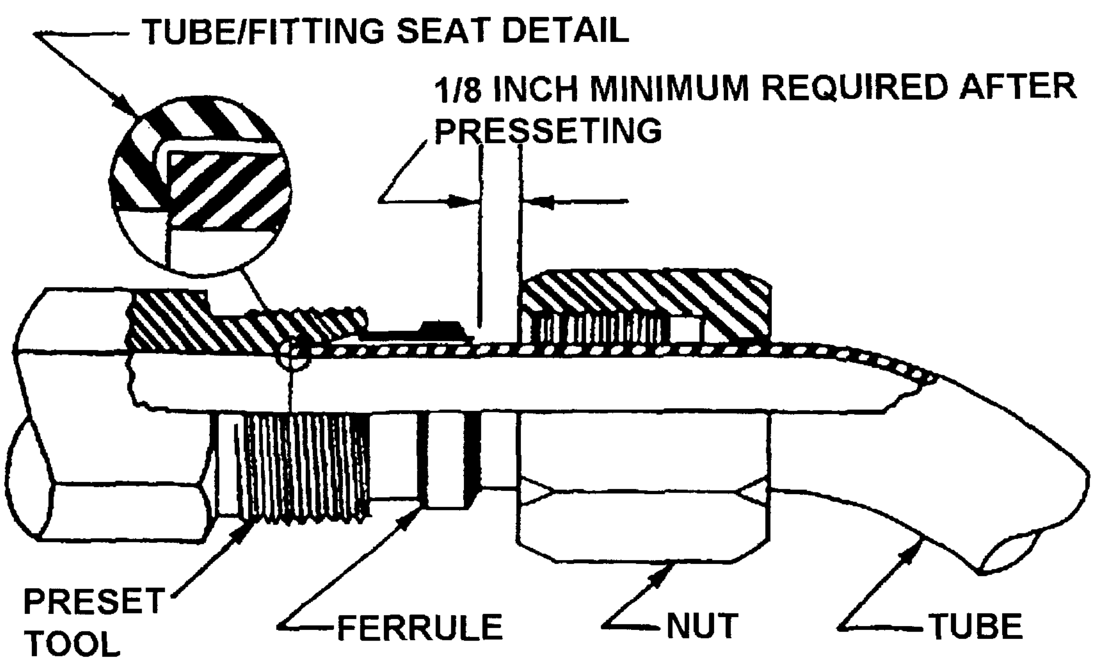


Figure 505-6-10. Tube and Ferrule Assembled for Presetting, Showing Nut Position Required for Inspecting Ferrule.

CAUTION

Do not install ferrules of CRES 304 rather than the required CRES 17-4-PH. The softer CRES 304 ferrules may not obtain a satisfactory bite on hard materials (CRES and carbon steel) and shall not be used. To date, discrepant (CRES 304) ferrules have not been marked with the knurl used to indicate CRES 17-4-PH, so do not use CRES ferrules without the knurl. In case of doubt, use a small magnet to pick up the ferrule; CRES 17-4-PH is strongly magnetic and can be picked up, while CRES 304 is nonmagnetic and will not be picked up.

Table 505-6-6. SELECTION OF FLARELESS FITTINGS

Tubing Material	Sleeve or Ferrule	Body and Nut
CS	17-4-PH or CS	CS
CRES	17-4-PH	CRES
70-30 CuNi	17-4-PH	CRES
70-30 NiCu	17-4-PH (Monel)	CRES
Notes: 1. CS = carbon steel. Carbon steel ferrules are smooth on their largest diameter. 2. CRES = corrosion-resisting steel (any 300 series CRES). 3. 17-4-PH = corrosion-resisting steel CRES (type 17-4-PH). Ferrules of this material have a light knurl on the largest diameter (see 505-6-11). 4. Tubing shall be fully annealed. 5. Flareless fittings shall not be used with tubing materials other than those listed unless specifically approved. In no event should flareless fittings be used with copper or other very soft tubing materials in permanently installed systems.		

505-6.8.5.1.3 Ferrules or sleeves per MIL-F-18866 are of two types as shown in figure 505-6-11 (A) and (B). The flush-type ferrule has a flat cutting end (cutting edge flush with the end of the ferrule) [see figure 505-6-11 (A)]. The recessed type ferrule has the cutting edge recessed 0.015 to 0.032 inch behind an overhanging lip at the end of the ferrule [see figure 505-6-11(B)]. Inspection criteria are different for the two types, so note the type of ferrule before installation and presetting. The two types may still be identified after installation by a careful measurement of the installed length. Flush type ferrules will be approximately the same length after presetting as before presetting. Recessed type ferrules, which are shorter than the flush type as manufactured, may gain or lose a few thousandths of an inch during presetting. To identify the type of installed preset ferrule, compare its length to a nonpreset ferrule of the same tubing size, or to the lengths given in table 505-6-7.

505-6.8.5.1.4 Presetting consists of deforming the ferrule to bite into the tube OD, and deforming the end of the tube to form a shallow conical ring seating surface. The tube and ferrule assembly are preset in a presetting tool that has an end section identical to a fitting body but which is made of specially hardened steel. This hardness is needed to ensure all deformation goes into the tube to form the conical ring seating surface.

505-6.8.5.1.5 A fitting body is not specially hardened and shall not be used to preset tube and ferrule assemblies if a presetting tool can be obtained. If a presetting tool cannot be obtained, a fitting body may be used to preset only the tube and ferrule that will be assembled with it. The fitting body seat may not be hard enough to properly form the conical ring seating surface on the tube end. As a result, the fitting body and tube and ferrule assembly may work properly only as a matched pair. Leaks may result if the tube and ferrule assembly is used with other fitting bodies, if the presetting fitting body is used with other tubes, or if the original matched pair are disassembled and reassembled in a slightly different orientation. Therefore, limit use of fitting bodies for presetting to urgent repairs that have to be performed when a presetting tool can not be obtained.

505-6.8.5.1.6 Presetting can be accomplished with a hydraulic presetting tool or a manual presetting tool, either in the shop or aboard ship. The tool vendor instructions are to be followed for the hydraulic presetting tool. The manual tool is used as follows (if a presetting tool is not available, the fitting body intended for installation is used in the same manner as the manual presetting tool):

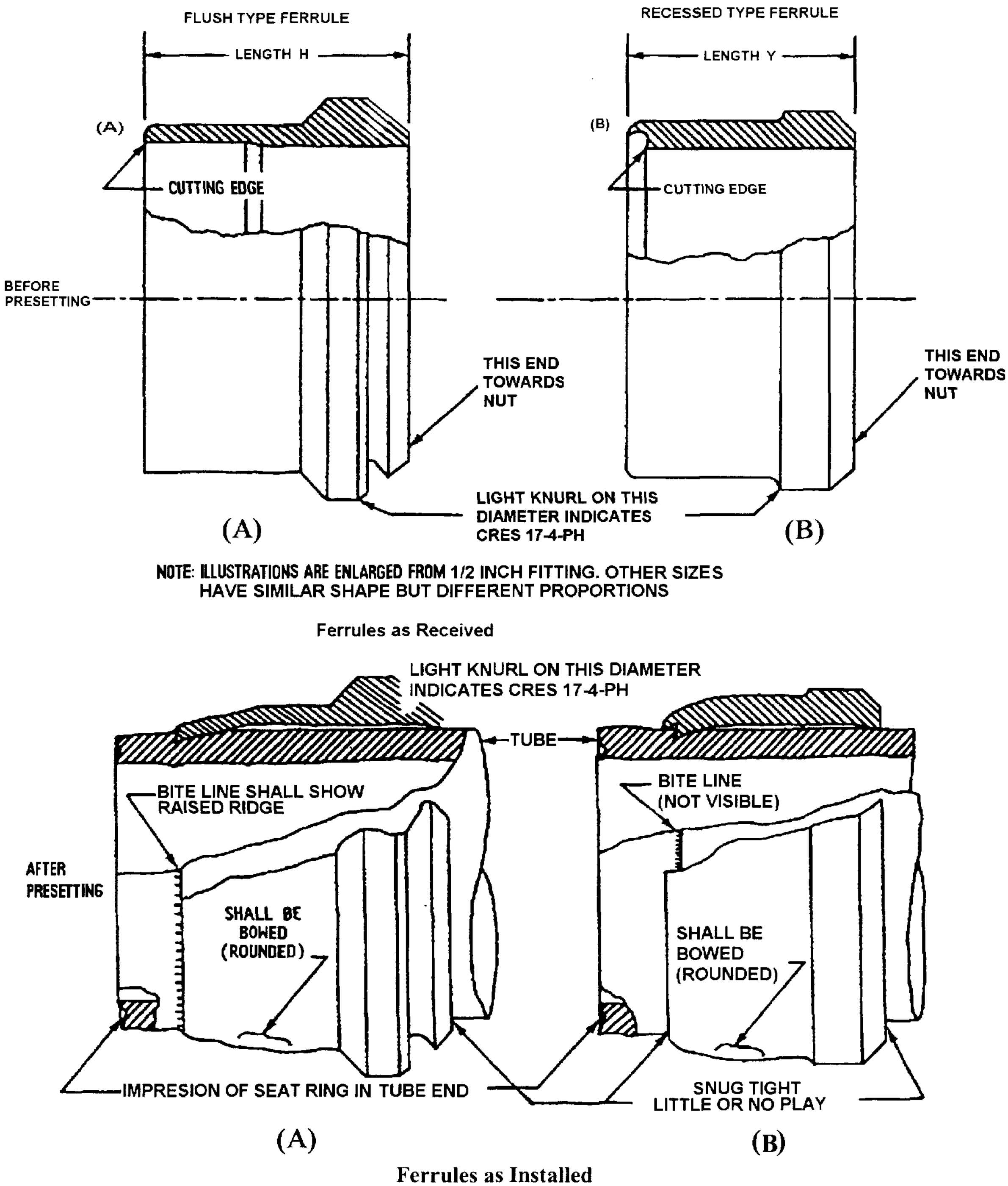


Figure 505-6-11. Ferrules.

WARNING

Failure to follow these instructions may result in improperly preset ferrules with insufficient bite into the tube. Improperly preset ferrules have resulted in joints that passed hydrostatic testing and operated for weeks or years, then failed catastrophi-

Warning - *precedes*

cally under shock, vibration, or normal operating loads. Flareless fitting failures have caused personnel injury, damage to and unnecessary interruption of propulsion power.

a. Cut tubing square and lightly deburr inside and outside corners. For corrosion-resistant steel (CRES) tubing, use a hacksaw rather than a tube cutter to avoid work hardening and deforming the tube end. For CRES, and if necessary for other materials, dress the tube end smooth and square with a file. Tube ends with irregular cutting marks will not produce satisfactory seating surface impressions.

b. Test the hardness of the ferrule by making a light scratch on the tubing at least 1/2 inch back from the tube end, using a sharp corner on the ferrule. If the ferrule will not scratch the tube, no bite will be obtained. Moderate hand pressure is sufficient for producing the scratch. This test may be omitted for flush-type ferrules where the bite will be visible.

c. Lubricate the nut threads, the ferrule leading and trailing edge, and the preset tool threads with a thread lubricant compatible with the system service. Slide the nut onto the tubing so that the threads face the tube end. Note whether the ferrule is flush type or recessed type (see figure 505-6-11) and slide the ferrule onto the tube so that the cutting edge is towards the tube end (large end towards the nut).

Table 505-6-7. FERRULE OR SLEEVE LENGTH AS MANUFACTURED (±0.003 INCH)

Tube OD Inches	Flush Type (Dimension H of Figure 505-6-11)	Recessed Type (Dimension Y of Figure 505-6-11)
1/8	0.288	0.278
3/16	0.329	0.278
1/4	0.363	0.336
5/16	0.367	0.336
3/8	0.393	0.375
1/2	0.429	0.375
5/8	0.442	0.415
3/4 to 1-1/2	0.475	0.415
2	0.509	0.450

d. Bottom the end of the tubing in the presetting tool. Slide the ferrule up into the presetting tool and confirm that the nut can be moved down the tube sufficiently to expose at least 1/8 inch of tubing past the ferrule when preset to allow for inspection of the ferrule (see figure 505-6-10).

e. For flush type ferrules (see figure 505-6-11(A)), while keeping the tube firmly bottomed, tighten the nut finger tight. Mark the nut and the presetting tool at this position. Tighten the nut an additional 1 3/4 turns on all tubing sizes.

f. For recessed type ferrules (see figure 505-6-11(B)), while keeping the tube bottomed, slowly rotate the tube back and forth in the presetting tool or the fitting body, tighten the nut until the tubing no longer rotates and, the ferrule just grips the tubing by friction. Mark the nut and the presetting tool at this position. Tighten the nut according to the number of turns given in table 505-6-8, depending on tube size.

Table 505-6-8. NUMBER OF TURNS

Tube OD Inches	Number of Turns
1/8 to 1/2	1-1/6 (seven flats of the nut)
5/8 to 7/8	1 (six flats)
1	5/6 (five flats)
1-1/4 to 2	1 (six flats)

505-6.8.5.2 Disassembly and Inspection. Disassemble and inspect the fitting as follows (mandatory):

a. The end of the tubing shall have an impression of the presetting tool seat surface (circular appearing ring) for 360 degrees. A partial or visibly off center ring is unsatisfactory.

b. Check proper bite:

   1. For flush-type ferrules a raised ridge of tube metal shall be visible completely around the tube at the leading edge of the ferrule. The best practice is to obtain a ridge having a thickness about 50 percent of the ferrule edge thickness.

   2. For recessed-type ferrules, the leading edge shall be snug against the tube OD, determined visually and by attempting to rock the ferrule on the tube.

c. Tightly collapse the nut end of the ferrule (both types) around the tube to provide support against bending loads and vibration.

d. The ferrule (both types) shall have little or no play along the direction of the tube run as checked by trying to move the ferrule back and forth by hand. The ferrule will often be free to rotate on the tubing; this does not affect its function.

e. For flush-type ferrules, check that the gap between the raised metal ridge and the cutting end of the ferrule stays the same as the ferrule is rotated. (Omit this check for recessed-type females or if the flush-type ferrule will not rotate on the tube).

f. Check that the middle portion of the ferrule (both types) is bowed or sprung into an arc. The leading edge of the ferrule may appear flattened into a cone shape; this is acceptable as long as there is a bowed section near the middle of the ferrule. If the whole leading section of the ferrule is flattened into a cone with no bowed section, the ferrule (and possibly the fitting body, if used) has been damaged by overtightening and will not seal reliably.

505-6.8.5.3 Reassembly of Fittings. Just before reassembly, inspect tube and ferrule assemblies that have been previously preset and that are being reinstalled, per paragraph 505-6.8.5.1.1. To reassemble a preset tube and ferrule assembly into the fitting body, lubricate the nut and fitting threads with a suitable lubricant, if required, then handtighten the nut. Continue tightening the nut slowly with a wrench until a sharp increase in torque is felt (this may be almost immediately past hand-tight for a fitting in good condition). From the point of sharp torque increase, tighten the nut an additional 1/6 to 1/4 turn (1 to 1-1/2 flats on the nut) to spring the ferrule firmly against the fitting wall. Do not overtighten; as little as 1/2 turn past the torque increase point may damage the ferrule or tube and fitting body seat and cause leakage.

SECTION 7
INSTALLATION

505-7.1 PIPING STRESSES

505-7.1.1 Allowable stresses for piping in the various systems are established during the design of each ship class. Pipe wall thicknesses and pipe support spacings are selected to keep the pipe stresses within the established limits. For some piping materials and services, extra wall thickness is included to protect against physical damage. However, piping should never be used to support chain falls or otherwise subjected to unusual loads or forces.

505-7.2 PIPING FLEXIBILITY REQUIREMENTS

505-7.2.1 GENERAL. All piping materials will expand when heated and contract when cooled. In addition, equipment to which the piping is attached and the various structures to which the pipe supports are attached all move relative to each other due to the working of the ship in the seaway. For some systems, the equipment nozzles to which the pipe is attached move significantly due to thermal expansion, vibration, or mechanical loads.

505-7.2.2 EXPANSION LOOPS. Wherever possible, loops, U-shaped bends, offsets, doglegs, and similar configurations are designed into the piping system to provide the flexibility necessary to accommodate the various movements. This is the most rugged and cost-effective method of providing the required flexibility.

505-7.2.2.1 The piping support systems, and some bulkhead and deck penetrations, are designed to permit the required movement of the pipe under normal operating conditions while restraining the piping under dynamic loads such as vibration, ship motion in heavy seas, and shock.

505-7.2.3 FLEXIBLE EXPANSION JOINTS. Flexible piping devices are used in some applications where adequate flexibility or sound isolation cannot otherwise be provided. There are five types of flexible piping devices in use aboard ship. Two of these, rubber hoses and rubber inserted sound isolation couplings (RISICs), provide sound isolation as well as flexibility. See paragraph 505-10.6 for additional information on these two components. Rubber bellows joints without tie rods will also provide some sound isolation but are generally not used for that purpose. The other three types are metal bellows, packed sliding joint, and packed ball and socket joint. Rubber bellows joints are only used in carefully controlled, selected applications and their use requires specific Naval Sea Systems Command (NAVSEA) approval.

505-7.2.3.1 In most piping configurations, the pressure in a pipe tries to elongate or stretch the pipe in the axial direction. Normally this elongation is restrained by the pipe walls and no significant movement occurs. When bellows type or packed-sliding-type expansion joints are installed in a pipe line, they act like a piston in a cylinder, and the pipe flanges to which the joints are attached will be forced apart (or pulled together in a vacuum system). If this movement is not restrained by appropriate piping supports, the joints themselves as well as the attached piping can be damaged. Of course low-pressure systems such as atmospheric vents or drains do not generally present a problem. Note that boiler safety valve discharge piping and some other relief valve discharge piping is not lowpressure piping. Long bellows joints with a number of convolutions present an additional problem. Even though the piping is properly restrained at each end of the joint, the long bellows element itself will try to bulge sideways out from between the end flanges. This is called bellows squirm, and tends to happen suddenly with disastrous results.

505-7.2.3.2 When the piping support system was designed, special supports were installed to handle the pressure thrust forces generated at expansion joints. These supports may consist of a number of devices such as guides to control the direction of the pipe movement, tie bars to limit the movement of bellows or prevent bellows squirm, or even anchors to resist axial forces in the piping system. When working on these joints and their supports, make sure that the adjustments and alignments specified on the piping drawings are maintained. These supports should also be checked for proper adjustment during routine maintenance.

505-7.2.3.3 Rubber hose configurations, RISICs, and packed ball and socket assemblies do not have the pressure thrust problems associated with bellows and sliding joints. There are, however, some special support requirements for these fittings. A substantial support should be attached to one or both ends of the joint assembly to hold the piping in position and support the weight of the fittings. A special support may also be attached to the center of the joint assembly to carry part of the assembly weight or to stabilize a dog-leg hose configuration. It is important to keep all of these supports in proper alignment to prevent premature failures.

505-7.2.3.4 When repairing or maintaining packed sliding or ball and socket joints, make sure that the packing is tight enough to prevent leakage but not so tight as to restrict motion.

505-7.2.3.5 Some flexible hose assemblies may be installed using only one hose bent into a 90-degree dog leg. This configuration is only acceptable for smaller size hoses and certain services. When replacing flexible hoses do not substitute a single bent hose for two straight hoses and an elbow fitting.

505-7.3 COLD SPRINGING

505-7.3.1 High-temperature piping systems are sometimes cold-sprung to reduce nozzle loads and pipe stresses under normal hot operating conditions. If a piping system has 100-percent cold spring, thermal expansion stresses and nozzle loads will be zero at the hot operating condition where the material is the weakest, and the highest at the cold condition where the material is the strongest. These features are designed into the piping and must be maintained following maintenance or repair work.

505-7.3.2 Cold-springing is illustrated in the boiler-to-turbine piping shown in figure 505-7-1 and figure 505-7-2. Assume that the piping shown in figure 505-7-1 is 100-percent cold-sprung, at its hot operating condition, but is not pressurized. Under these conditions the flanges at the connection to the turbine will be aligned. The flange fasteners could be removed without any resultant flange movement. However, as the piping cools it shrinks, causing the flanges at the turbine to separate (assuming the flange fasteners are removed). The separations shown in figure 505-7-2 occur in the X and Y planes, as indicated. Movement can occur in all three planes. To achieve 100-percent cold-spring at the hot condition, the flanges at the turbine will be separated, as shown in figure 505-7-2, at assembly when the piping is cold. Consult system diagrams to identify the cold-spring separations applicable to specific systems, and for procedures for assembling flanges when the piping is cold. Refer to General Specifications for Overhaul (GSO) 505 if additional information is required.

505-7.4 JOINT ALIGNMENT

505-7.4.1 In general, all pipe joints, flanged, union, screwed, or welded, have some bending stresses across them. Think of a straight section of 1-inch schedule-40 pipe 100-feet long, supported every 20 feet by rigid pipe supports. If the pipe is cut in two halfway between two center supports, the two cut ends will tilt and rotate down as illustrated in figure 505-7.3. If the pipe is cut 2 feet from one of the supports, the section nearest the support would tilt and rotate up while the longer section would tilt and rotate down as illustrated in figure 505-7.4. Now install flanges on the cut pipe ends and prepare to bolt them together. Check to see if the flanges are properly aligned. Obviously the flange sealing faces are not parallel, but you should not expect them to be while the pipe ends are hanging free. No pipe joint will be in perfect alignment after it has been disassembled. The amount of misalignment will vary significantly because it depends on many factors, including piping diameter and wall thickness, pipe material, support spacing, location of the joint relative to the supports, and support type. These variables make it impractical to list the amount of misalignment expected in a given installation. Piping should not be pulled or forced into place in such a manner as to impose more than minor additional stress on connected piping, machinery, equipment and bolting material.

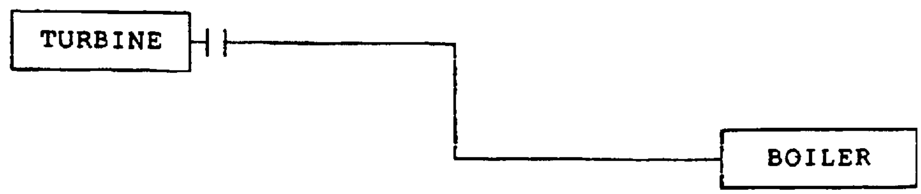


Figure 505-7-1. Turbine Flange Alignment at Hot Conditions

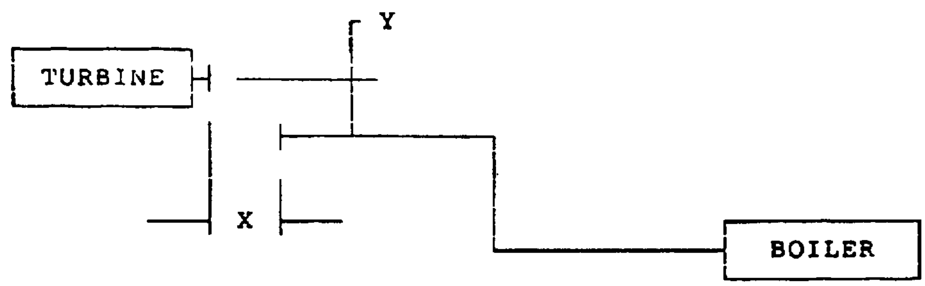


Figure 505-7-2. Turbine Flange Alignment at Cold Conditions

Figure 505-7-3. Joint Centered Between Supports

Figure 505-7-4. Joint Near Support

505-7.5 PIPE ANCHORS, SUPPORTS, AND SWAY BRACES

505-7.5.1 TERMINOLOGY. The terms, hanger and support, describe the various devices used to carry the weight of piping systems. Although often used interchangeably, hanger usually refers to a device that carries the piping weight from above, and support generally refers to a device that carries the piping weight from below. Support is commonly used in a broader sense to include any device that carries the piping weight from above, from below, or even from the side. This meaning for the term support is used in this section.

505-7.5.2 FUNCTION. Supports are arranged so that piping and component nozzle bending stresses, due to the weight of piping and inline components such as valves and strainers, are minimized. When heavy load concentrations such as vertical pipe runs, valves, and strainers are present, additional supports are provided.

505-7.5.3 PIPE SUPPORT TYPES. Supports are either of the rigid (fixed), spring, or resilient type. Rigid-type supports provide significant restraint in at least one direction. Spring supports are used where necessary to permit pipe movements due to thermal expansion, contraction, or working of the ship. Rigid supports are generally used in cold piping systems and may sometimes be used in hot piping systems at points of limited or single direction movement. Cold systems in this context mean systems where the fluid temperature does not exceed 120 degrees F. One end of the support is usually bolted or welded to a clamp on the pipe and the other end bolted or welded to ship structure. Pipe hangers for surface ships are shown on NAVSHIPS drawing 804-1385781. Pipe hangers for submarines are shown on NAVSHIPS drawings S4823-1385782 and 803-5001054. The submarine hangers are also used on surface ships.

505-7.5.3.1 Rigid. There are many different styles of rigid supports. A commonly used rigid support is the flat bar type shown in figure 505-7-5. Since the flat bar is relatively flexible in bending in one direction, it is often necessary to substitute support legs of either angle iron or pipe to provide the necessary rigidity to resist pipe movement that would occur because of ship motion or shock forces. An example of this type support is shown in figure 505-7-6. When the support leg is long and rigidity is required, frame type support legs similar to the one shown in figure 505-7-7 are used. Rigid supports are generally fabricated by the shipbuilder. However, shipyards sometimes purchase rigid supports from commercial suppliers. One type commonly used is shown in figure 505-7-8. The rigid style supports shown in figure 505-7-6, figure 505-7-7, and figure 505-7-8 are all nonadjustable. Adjustable rigid supports are shown in figure 505-7-9.

505-7.5.3.1.1 It is generally necessary to use some spring supports in hot piping systems because of the thermal movement of the piping. However, in many locations where the pipe movement is small, it is possible to use rigid style supports. Where the movement is larger but in the plane of the piping, rigid supports, which contain bolted joints in the support leg at both the pipe clamp and the ship structure, are sometimes used.

505-7.5.3.2 Variable Spring Force. Variable spring supports are generally used in hot piping systems to carry the weight of the piping while allowing movement of the piping because of thermal expansion. The variable spring pipe support consists of a heavy spring enclosed in a can that is attached to the ship structure. The spring supports the pipe by means of a rod and turnbuckle attached to the pipe with a standard pipe clamp. As the name implies, these supports will apply a variable force to the pipe, depending on how much the spring is deflected. The variable spring supports have hot and cold settings that are calibrated and marked by the manufacturer for each location. Care must be taken to ensure that these supports are always returned to their proper location following any repair work. Both the cold and hot load settings are calculated by the designer and facilitate adjusting the spring support. When the piping system is at its maximum operating temperature, the load indicator should be at the hot setting. This is more important than the cold setting which may be off some small amount. Figure 505-7-10 illustrates this type of support.

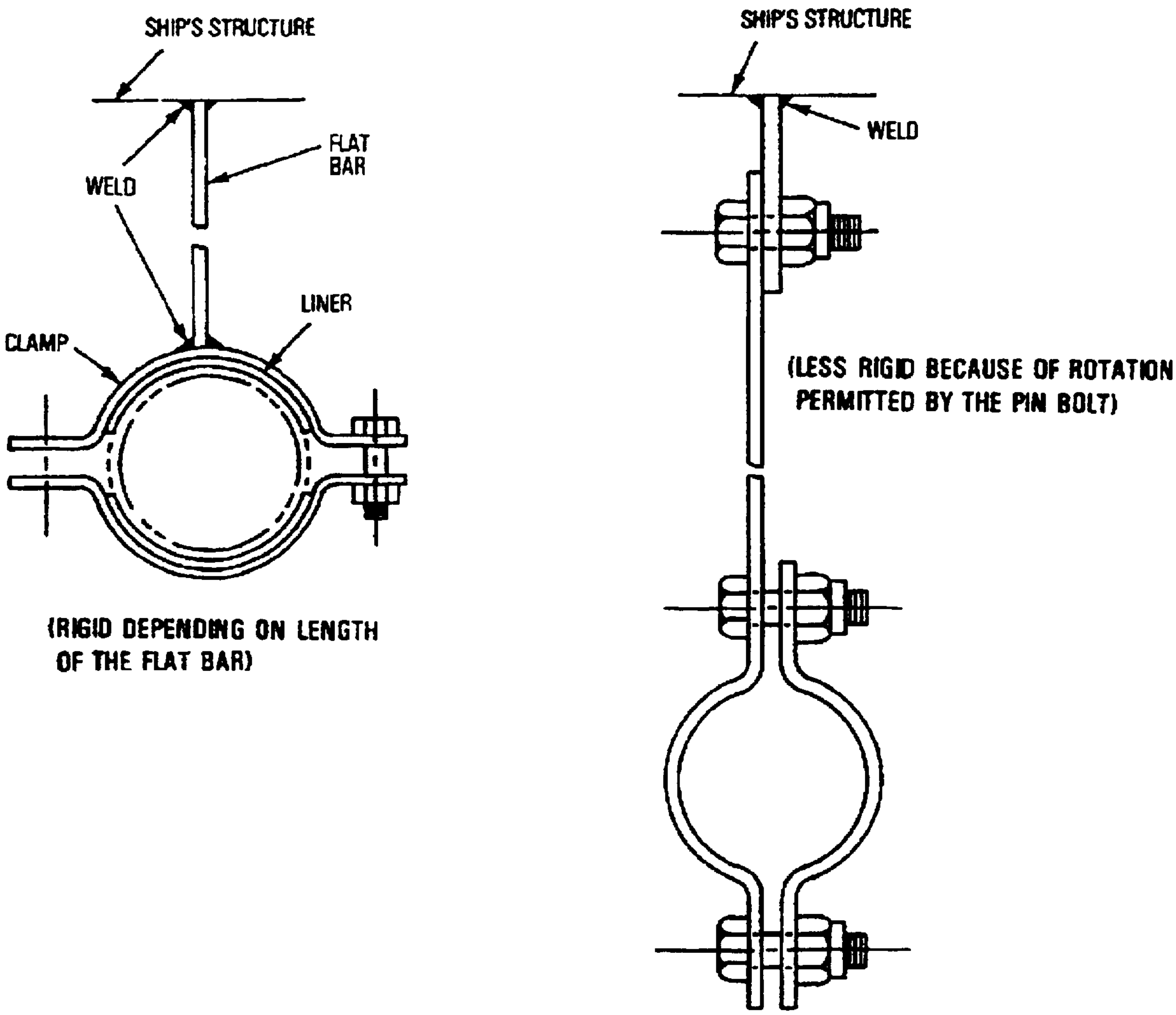


Figure 505-7-5. Flat Bar Rigid Support.

505-7.5.3.3 Constant Force. Where a constant supporting force is required for the piping throughout the support's travel, a constant force support is used. These will generally be found near turbine inlet nozzles and other places with significant vertical movement. The constant force is achieved by a bell crank linkage between the spring and the support rod. The frame portion of the hanger is attached to the ship structure or foundation, and the lever is attached to the pipe clamp with a rod turnbuckle. Figure 505-7-11 shows some applications and examples of this type of support.

505-7.5.4 ANCHORS AND SWAY BRACES. Piping requires lateral support to damp out vibration of the piping and prevent excessive pipe motion during heavy seas or high impact (HI) shock. Anchors, sway braces, or both are provided to control these dynamic loads.

505-7.5.4.1 Anchors. Anchors generally consist of structural members welded to the pipe and bolted to ship structure such as a deck or bulkhead. The attachment to the pipe should consist of a split collar or sleeve welded to the piping and the structure members welded to the collar. This will prevent high stress areas in the piping material. Anchors should only be used where specified by class design drawings.

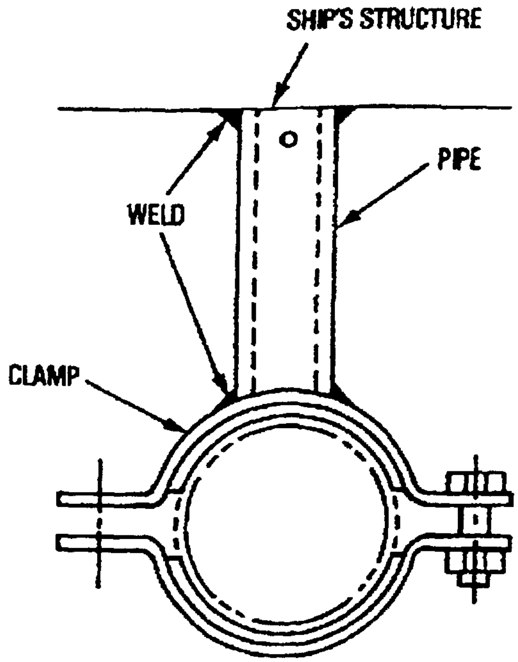


Figure 505-7-6. Fixed Pipe

505-7.5.4.2 Sway Braces. Sway braces are generally mounted horizontally and are not designed to support the weight of the piping. The sway braces are adjusted so that they apply no force to the pipe in the hot condition but provide restraint against piping motion because of dynamic loads. Figure 505-7-12 illustrates some examples of sway braces. As shown on the lower sketch, some old style sway braces are provided with tension test collars to determine if the spring plates are against the end plates (neutral position) and whether there is clearance between the rod coupling and the spring plate. The tension test collar is adjusted so that it is hand-tight when the piping system is hot, indicating that the sway brace is in the desired neutral position.

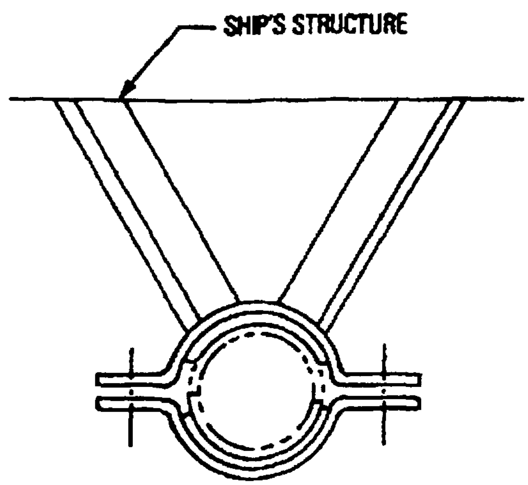


Figure 505-7-7. Frame Type Support

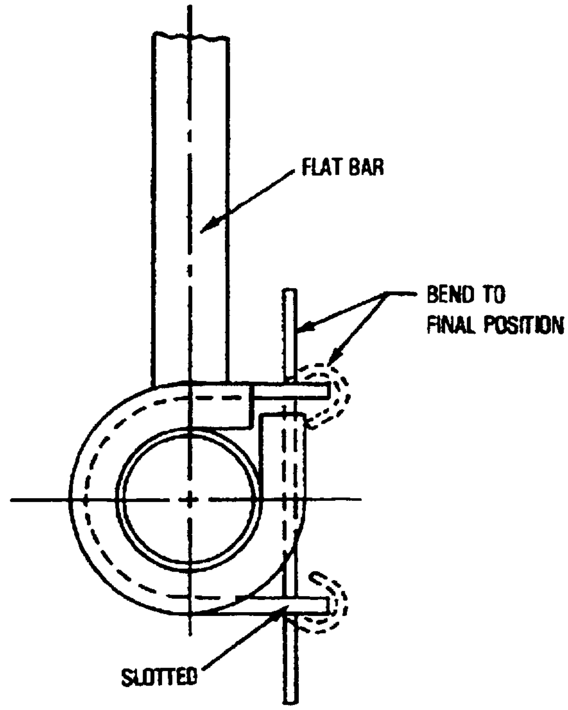


Figure 505-7-8. Strap Hanger

505-7.5.5 RESILIENTLY-MOUNTED PIPE SUPPORTS. Some shipboard equipment is very noisy. To prevent this noise from interfering with ship sonar, and to prevent the noise from being radiated into the water, this equipment is mounted on resilient mounts. To allow the equipment to move on its mounts and to provide additional sound isolation, any piping associated with this equipment is usually attached by rubber hose or RISIC assemblies. As an additional precaution, supports for this piping are usually attached to the ship structure by resilient mounts. Figure 505-7-13 illustrates some examples of this type of support. Single element hanger designs which provide sound isolation are also being developed.

505-7.5.5.1 Resiliently mounted pipe supports must be properly maintained and kept in proper adjustment. Do not paint the rubber elements or nonferrous material, but paint the metal parts. Paint applied to resilient mount rubber elements serves as a path for equipment noise to radiate into the water. The adjustments are made with the upper and lower load nuts on the support rod. Lengthen or shorten the support rod until the distance between the rubber element mounting flange and the load flange is within the dimensions given on the support installation drawings.

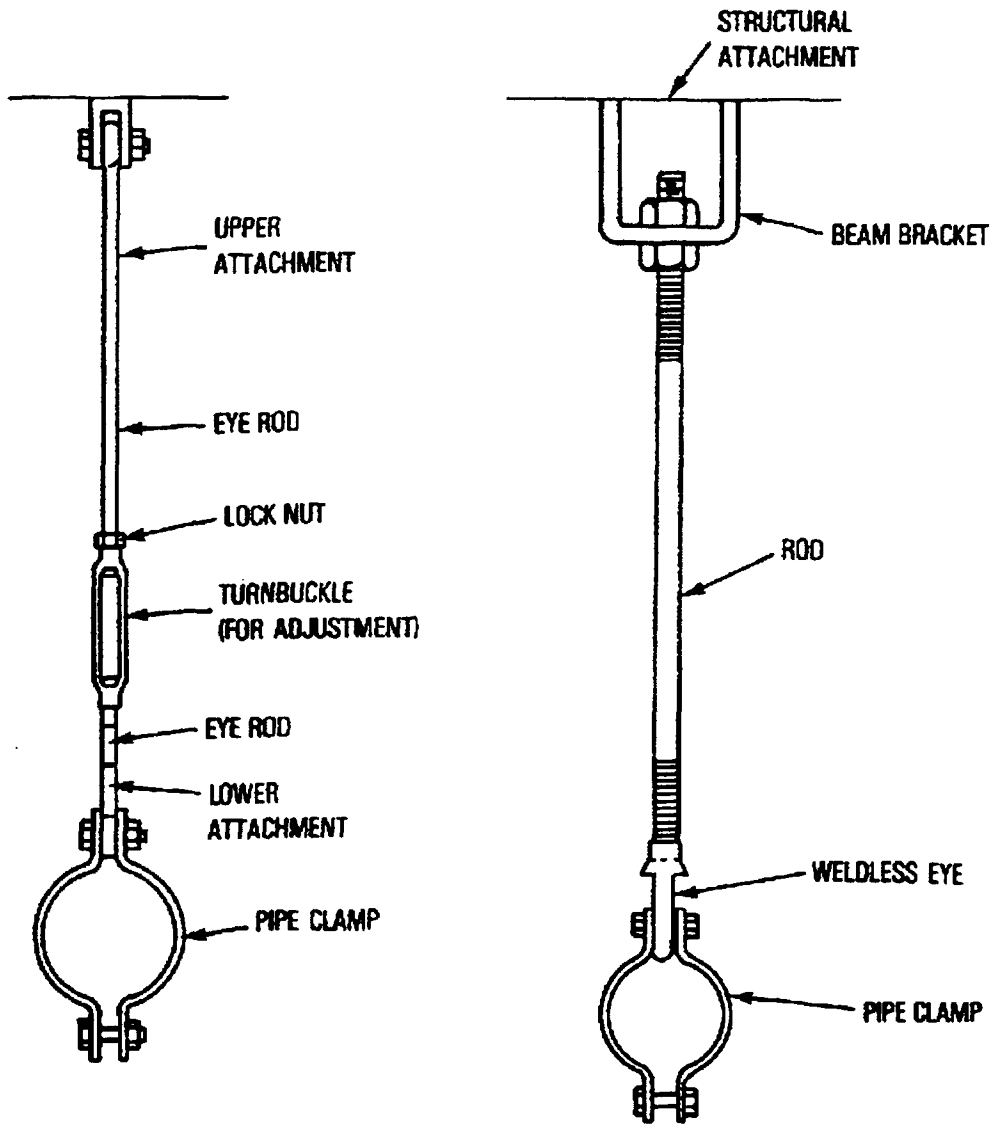


Figure 505-7-9. Rigid Type - Adjustable

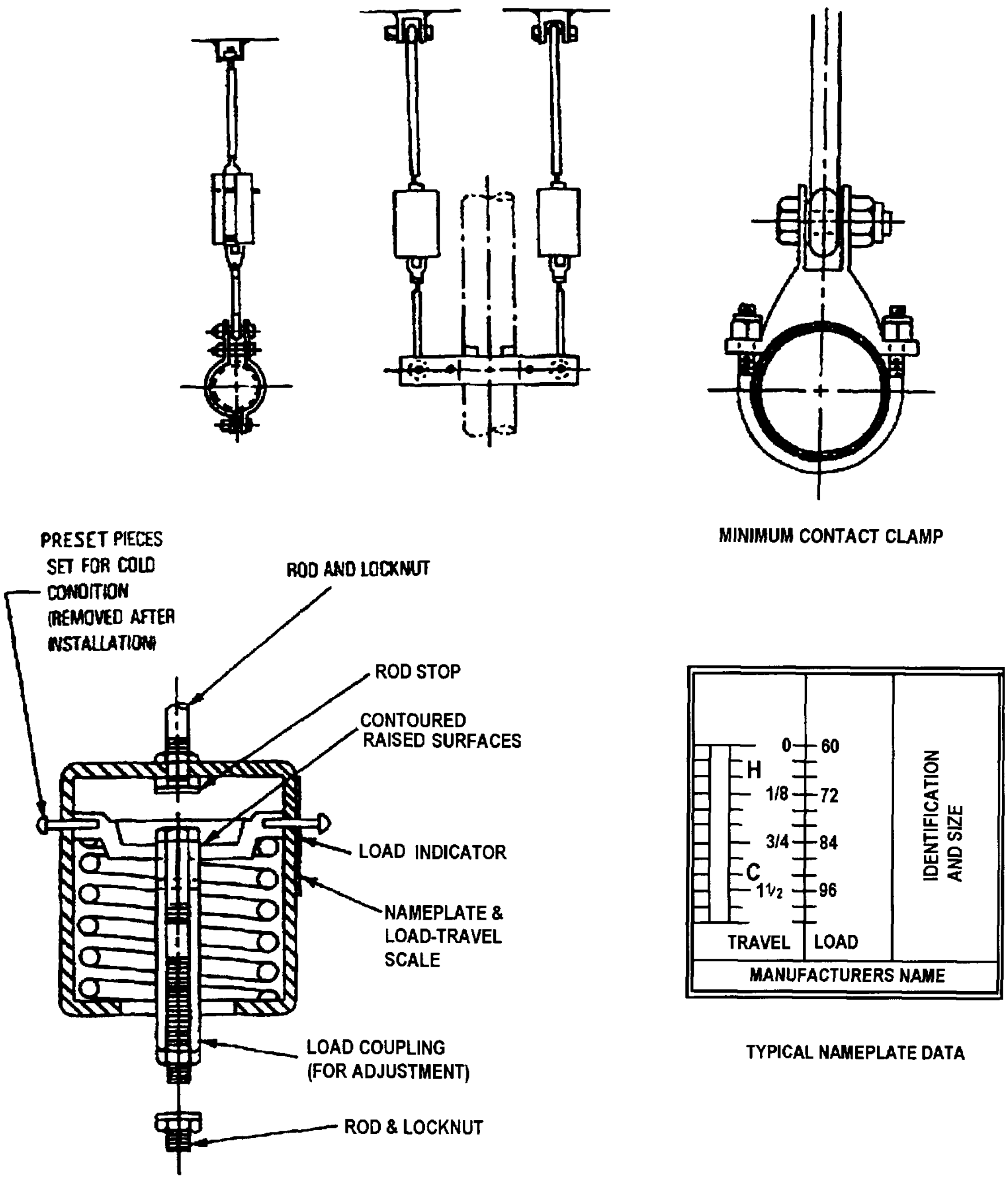


Figure 505-7-10. Variable-Spring-Type Supports

505-7.5.6 PIPE SUPPORT CLAMPS. Pipe clamps are generally used to secure the support to the pipe. The two halves bolt together with the pipe clamped firmly between them. Clamps permit easy removal of piping sections. Clamps are usually designed so that a specified clearance exists between the ends of the two clamp halves. Avoid overtightening the clamp bolts since this can result in deformation of the clamps and possible crimping of non-ferrous piping. However, the clamps must be snug against the pipe liner.

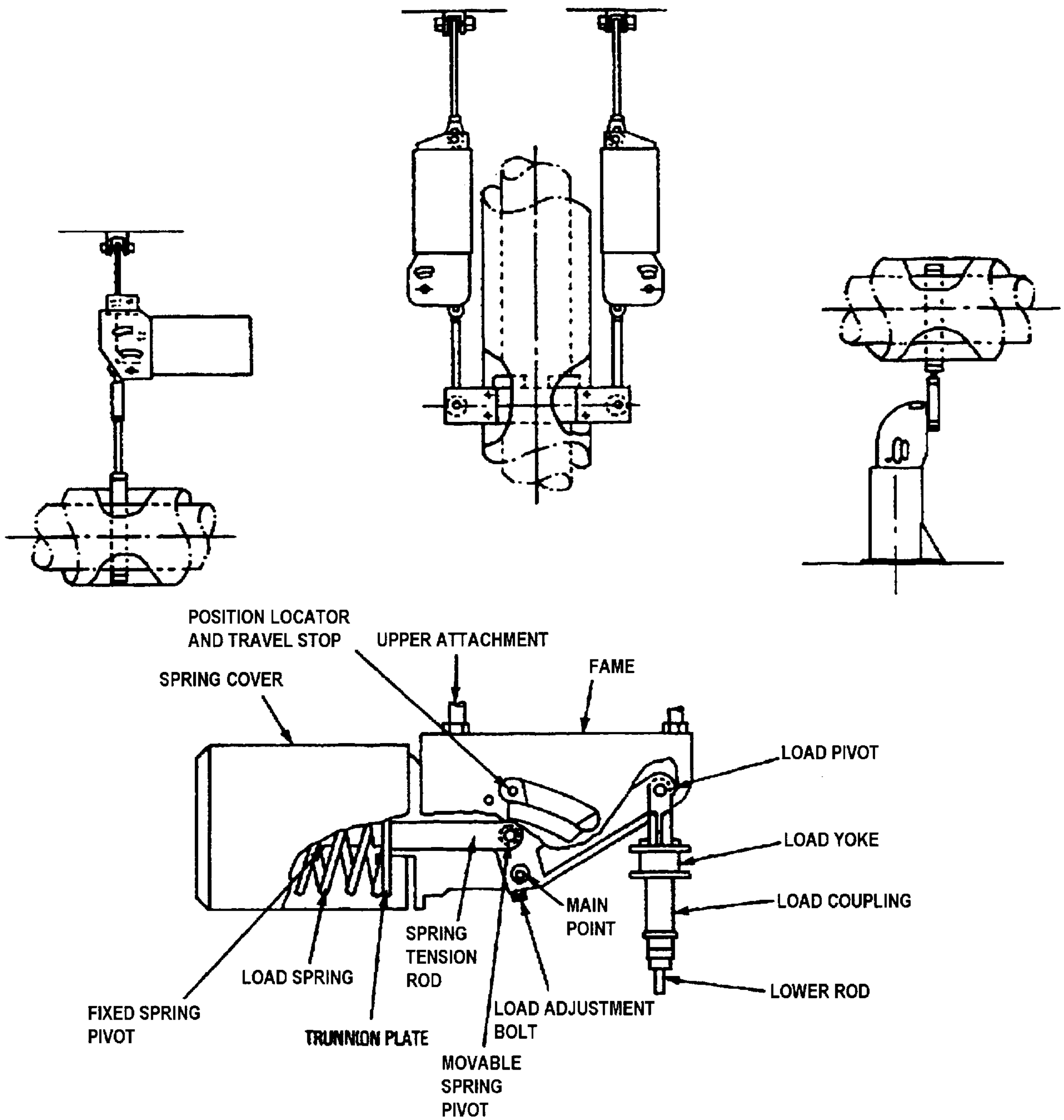
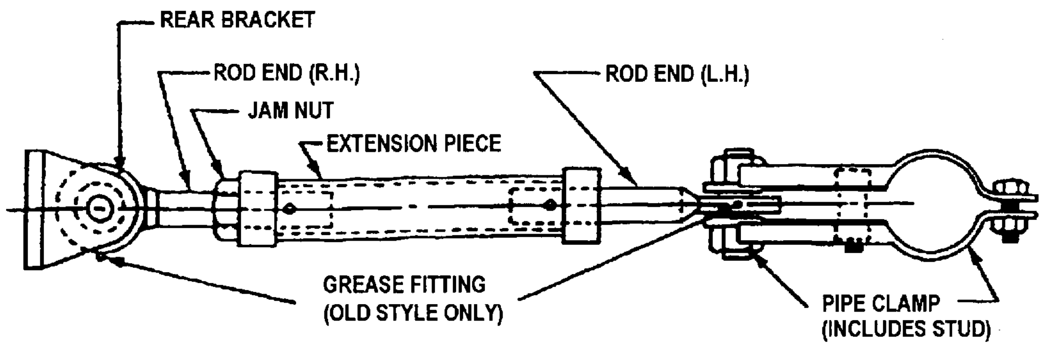


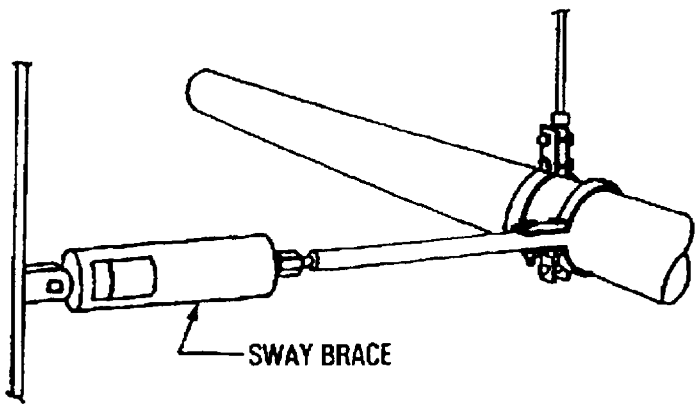
Figure 505-7-11. Constant-Type Supports

505-7.5.6.1 Pipe Clamp Liners. To minimize the transmission of heat through pipe hangers and supports and prevent damage to the pipe, clamps are lined with either rubber or fiberglass. However, some older ships may still have asbestos pipe hanger liner material installed. Material containing asbestos is not to be installed as a liner under any circumstances.

505-7.5.7 MAINTENANCE REQUIREMENTS. Conduct preventive maintenance on all hot piping system supports, spring supports, resiliently-mounted supports, or sway braces in any other systems in accordance with applicable Maintenance Requirement Cards (MRCs).



SWAY STRUT ASSEMBLY



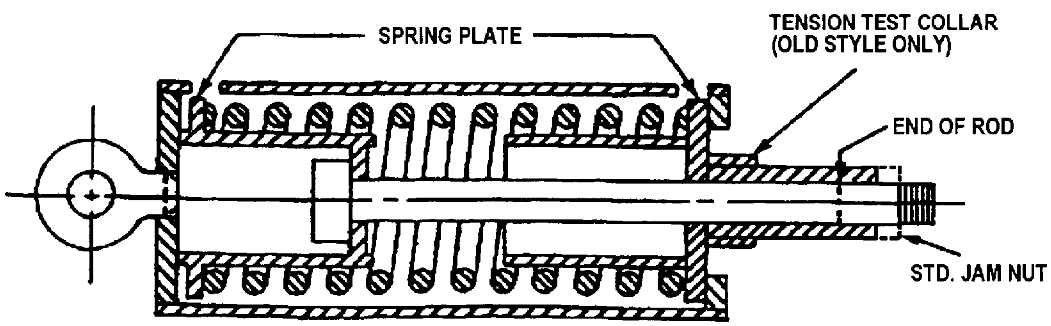


Figure 505-7-12. Sway Braces.

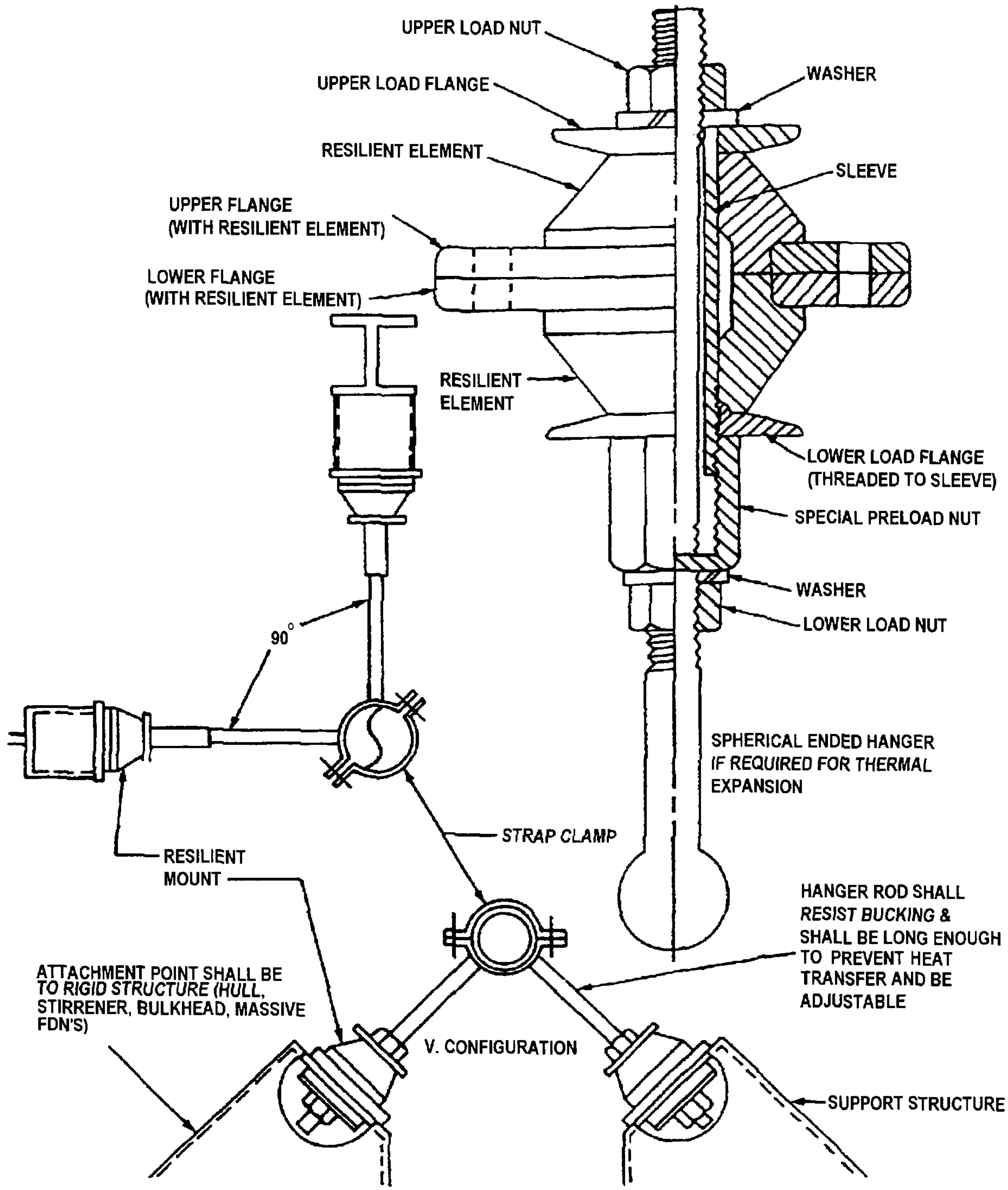


Figure 505-7-13. Noise-Isolation-Type Pipe Supports

505-7.6 FABRICATION AND INSTALLATION

505-7.6.1 GENERAL. Welding and brazing of piping systems, and the inspection of joints, shall be done according to section.

505-7.6.2 PIPE AND TUBING BENDS. Fabrication and control of piping and tubing shall be according to

MIL-STD-1627, Bending of Pipe or Tube for Ship Piping Systems. Minimum wall thickness for piping or tubing extrados (outer wall) after bending shall not be less than the minimum design wall thickness required for straight piping or tubing.

505-7.6.2.1 For piping or tubing bent to a radius of 5 diameters or more, no additional wall thickness is required at the intrados (inside radius of the bend) over that of straight piping or tubing of the same size, material, and pressure rating.

505-7.6.2.2 For piping or tubing bent to a radius of less than 5 diameters, the piping or tubing intrados shall have wall thickness greater than that required for straight piping or tubing of the same size, material, and pressure rating; such that, the resulting intrados membrane stresses do not exceed specified maximum allowable stresses.

505-7.6.2.3 Make branch connections in piping by using integral fittings such as tees, laterals, and crosses, wherever possible. Fabricated branch outlets such as saddles and plate reinforcements are permitted only with specific NAVSEA approval. Obtaining required reinforcement through weld buildup is not permitted, and any branch connection fabricated by welding is considered unreinforced.

505-7.6.3 INSULATION. Refer to NSTM Chapter 635, **Thermal, Fire, and Acoustic Insulation** , for additional information.

505-7.6.4 PAINTING. Paint piping according to NSTM Chapter 631, **Preservation of Ships in Service (Surface Preparation and Painting)** . External corrosion of ferrous piping is normally caused by not keeping the exterior properly painted and free of moisture. Piping shall be clean and grease-free for satisfactory painting. In many cases it is necessary to complete painting before installation.

505-7.7 CLEANLINESS

505-7.7.1 GENERAL. The cleanliness requirements for piping systems vary widely. Take care to ensure that new, replaced, or repaired piping meets the cleanliness requirements for the applicable system. Refer to ship drawings, appropriate sections of this chapter, and to other appropriate NSTM Chapters such as 050, **Readiness and Care of Inactive Ships** ; 262, **Lubricating Oils, Greases, Hydraulic Fluids and Lubricating Systems** ; 516, **Refrigerating Systems** ; 551, **Compressed Air Plants** ; and 556, **Hydraulic Equipment, Power Transmission and Control** , for information on specific systems.

NOTE

For steam plant cleanliness requirements on nuclear ships, refer to NAVSEAINST 9210.36, Steam Plant Cleanliness Control, and NAVSEA 0989-064-3000, Cleanliness Requirements for Nuclear Propulsion Plant Maintenance by Forces Afloat.

505-7.7.2 DEBRIS. Debris in piping systems is a common cause of heat exchanger clogging and valve problems. Before installing any section of piping or making up any piping connection, ensure that piping is clear of obstructions and that the affected sections have been properly cleaned.

505-7.7.3 PIPE COVERS. Use of material such as foam rubber or rags internally at pipe ends for cleanliness protection covers is prohibited. Minimize use of internal hard plugs, as these items frequently are overlooked and not removed when reconnecting piping. Use blank flanges or other hard coverings external to piping to the maximum extent practicable. Temporary filters or strainers may be used in new or repaired piping systems to remove debris when flushing or starting up the system.

505-7.7.4 BRAZED PIPING SYSTEM. Special category P-3a brazed piping systems, as defined in NAVSEA 0900-LP-001-7000, **Fabrication and Inspection of Brazed Piping Systems** , and potable water piping systems shall be cleaned per the procedures specified in 0900-LP-001-7000, Section 5.8. Fluorocarbon and non-fluorocarbon refrigerant piping systems shall be cleaned per NSTM Chapter 516, **Refrigeration Systems** . Hydraulic piping systems shall be cleaned per NSTM Chapter 556, **Hydraulic Equipment** (Power Transmission and Control) and MIL-STD-419, **Cleaning, Protecting, and Testing Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment.** Cleaning by the hot flushing and hot recirculation methods are preferred. These systems are cleaned to remove any remaining flux or scale. Cleaning shall be accomplished prior to hydrostatic testing.

505-7.7.5 OXYGEN SYSTEMS. Clean oxygen systems following assembly and before placing in service in accordance with MIL-STD-1330, **Cleaning and Testing of Shipboard Oxygen, Nitrogen and Hydrogen Gas Piping Systems** . Clean is defined as being free of all loose scale, rust, grit, filings, oil, grease, and other foreign substances and hydrocarbons.

505-7.7.5.1 Oxygen equipment received from a manufacturer with a statement that it has been cleaned for oxygen service need not be recleaned, provided the means for protecting the equipment is intact.

505-7.7.5.2 Clean shipboard oxygen distribution systems according to MIL-STD-1330. Alternative cleaning procedures using an alkaline cleaning solution may be used with NAVSEA approval.

505-7.7.5.3 After the initial cleaning operation, the system need not be recleaned unless it has been opened to the atmosphere for modification or repair or unless the pressure drops below the minimum permissible operating pressure of 25 lb/in.^{2} for surface ships and 100 lb/in.^{2} for submarines.

505-7.7.6 FEEDWATER AND CONDENSATE SYSTEMS. To reduce the possibility of contaminating boilers, it is necessary to maintain clean feedwater and condensate systems. Grease, oil, or other foreign matter in suspension in the water tend to produce priming and the various corrosion processes reduce efficiency, and, if deposited on heating surfaces, possible overheating and serious damage.

505-7.7.6.1 General. To maintain clean feedwater and condensate systems, adhere to the minimum guidelines presented in paragraphs 505-7.7.6.2 through 505-7.7.6.4 for ships with oil-fired boilers. For various reasons, alternative flushing procedures may be necessary and are acceptable provided the method used ensures equivalent cleaning of all portions of the systems, and cleanliness acceptance criteria are met. Flush feedwater and condensate systems as near as practical to the time that they are placed in operation, to minimize the effects of system corrosion.

NOTE

For steam plant cleanliness requirements on nuclear ships, refer to NAVSEAINST 9210.36, Steam Plant Cleanliness Control, and NAVSEA 0989-064-3000, Cleanliness Requirements for Nuclear Propulsion Plant Maintenance by Forces Afloat.

505-7.7.6.2 Inspection. Regularly inspect feedwater and condensate systems for oil and foreign solid contaminants other than fine rust particles (about once a year depending on experience), and when oil or dirt contamination is suspected. This is done by opening and inspecting condenser hot wells, deaerating feed tanks (DFTs), and other feed tanks.

505-7.7.6.2.1 Inspection for contamination may be arranged to coincide with periodic inspections required for large components such as DFTs and condensers. If oil contamination occurs, locate the source, correct the fault, and clean feedwater and condensate systems using the procedures described in NSTM Chapter 050 and Chapter 255, **Feedwater System and Apparatus** . Clean boilers according to NSTM Chapter 221, **Boilers** . If oil or grease is present in the condenser, boil out according to the procedure in NSTM Chapter 254, **Condensers, Heat Exchangers, and Air Ejectors** .

505-7.7.6.3 Flushing. After periods of prolonged shutdown of feedwater and condensate systems (over six months with systems layup per paragraph 505-7.7.6.3.1 or over one year with systems in dehumidification layup per NSTM Chapter 050), or when the systems have been subjected to possible contamination due to overhaul or repair, flush with water to ensure that they meet the cleanliness criteria in paragraph 505-7.7.6.4. Following six week to six month periods when feedwater and condensate systems are not dehumidified, accomplish a low flow flush (without system strainers) of the main systems headers to available openings nearest the power generation source (boiler) until water is visually clear. If flushing reveals oils, chemically clean the feedwater and condensate systems according to NSTM Chapter 254 and Chapter 255.

505-7.7.6.3.1 To prevent excessive corrosion, for idle periods expected to last up to six weeks, keep system piping filled to the maximum extent practicable or fully drain. For idle periods between six weeks and six months, fully drain the piping or keep it filled to the maximum extent practicable. Draining the piping for six week to six month idle periods is preferable, but not mandatory. A few days after any system draining, reopen drains briefly to remove accumulated moisture. Where layup is not applicable, such as in condensers, prevent corrosion, if feasible, by dehumidification according to NSTM Chapter 050. For idle periods exceeding six months accomplish dehumidification, if feasible, of the condensate and feedwater systems per NSTM Chapter 050.

505-7.7.6.3.2 If overhaul or repairs have been performed, separately clean first the portions of the system that have been subjected to possible contamination to reduce the amount of flushing subsequently required. This also avoids the need for chemically cleaning the entire system. Thoroughly clean and descale the unit before flushing the entire system, particularly when repairs have been performed on large units, such as condensers, feedwater tanks, and DFTs.

505-7.7.6.3.3 Thoroughly clean the units after all grinding, chipping, descaling, and welding as follows:

a. Vacuum thoroughly.

b. Blowdown with dry air to drive remaining contaminants to the hot well.

c. Hose down with fresh water.

d. Flush directly to the bilge.

505-7.7.6.3.4 Onboard abrasive blasting of feedwater and condensate system components is not permitted. Remove rust by hand or power tool cleaning according to NSTM Chapter 631.

505-7.7.6.3.5 After overhauls, flush feedwater and condensate systems with water to ensure that the systems meet the cleanliness criteria of paragraph 505-7.7.6.4. If the flush discloses oil contamination, chemically clean the system according to NSTM Chapter 050 and Chapter 255. Before flushing condensate systems, open and clean the main condenser hot wells, DFTs, and other feedwater tanks of corrosion products.

505-7.7.6.3.6 Before system flush, install basket or cone-type strainers with temporary strainer elements in the suction side of the feedwater booster pumps or condensate pumps, as applicable, downstream of the isolation valve. For non-nuclear ships, strainer elements shall be 20 mesh or finer, but not finer than 30 mesh. They shall have sufficient area to limit pressure drop to an acceptable value. The maximum space between strainer element wires shall be 0.03 inch. For nuclear ships, see NAVSEAINST 9210.36, **Steam Plant Cleanliness Control.**

505-7.7.6.3.7 Strainers shall be designed for the maximum pressure differential they could experience if completely clogged. In addition, periodically check strainers for clogging or install means (such as measuring differential pressure between the inlet and outlet ports) to determine when strainers need cleaning. Take particular care to detect clogging of the strainer during initial flushing and periodically inspect the pumps for overheating or cavitation.

505-7.7.6.3.8 Use the following flushing procedure:

a. If desired, install white muslin or nylon bags in strainer basket,

NOTE

Strainer bags are not required, but may be used if desired. Muslin or nylon bags shall be equal to or better than the strainer with respect to size of particle removed and shall be made from cloth having at least 70 yarns-per-inch in the warp and fill directions.

b. All portions of contaminated feedwater and condensate piping should be flushed using the system fluid and pump for a minimum of two hours at the maximum achievable pump rate. As an alternative to using the system fluid only, on fossil fueled ships the condensate and feedwater piping may be first flushed with heated fresh water until suspended solids are reduced to required levels and then with heated feedwater quality water meeting the requirements of NSTM Chapter 220, **Boiler Water/Feedwater Water Chemistry** . The alternative flush with feedwater quality water shall be continued until effluent water conductivity is below 15-micro S/cm.

NOTE

Flushing fluid shall not pass through boilers or turbines.

c. Cycle all valves to ensure a complete flush.

NOTE

Evaporator distillate or equivalent may be used instead of feedwater.

d. If strainer bag is installed, inspect and change every 15 minutes.

e. Continue flushing, until cleanliness criteria are met.

f. Following completion of flushing evolutions, reopen, inspect and clean condenser hot wells, DFT's and feedwater tanks.

CAUTION

Do not use strainer bags during dockside testing or sea trial operations.

505-7.7.6.3.9 Retain temporary strainer elements during dockside testing. During initial operating at sea, up to 50-percent full power, a temporary strainer element may be installed in the suction side of the operating condensate pumps only, not in the standby condensate or feedwater booster pumps. If it is necessary to shift to the standby pump because of strainer element clogging, clean and replace the strainer element and restore the condensate pump, with the strainer element, to operation. Remove temporary strainer elements before any operation at sea above 50-percent full power. Where temporary strainer elements are installed, provide a tag in accordance with NAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL** with the following instruction: CAUTION: TEMPORARY STRAINER ELEMENT INSTALLED, REMOVE BEFORE OPERATION AT SEA ABOVE 50-PERCENT FULL POWER. Store strainer elements aboard ship for future flushing evolution.

505-7.7.6.3.10 If a temporary strainer element clogs during dockside operation, open and clean the strainer and upstream hot well, and replace the strainer element. Following operation at sea, and at the conclusion of overhauls, open and clean condenser hot wells and DFTs.

505-7.7.6.4 Acceptance Criteria. The cleanliness acceptance criteria are:

1. Filter bag or strainer is free of hard solid particles (grits, slag, brazing droplets, and metal chips) greater than 1/16 inch except that slivers or flakes may have a major diameter up to 1/8 inch. Rust flakes that are soft or crushable between fingers are acceptable.

2. Amounts of solid residue in filter bag or strainer at successive 15-minute intervals are reasonably constant, and the amount collected in one 15-minute interval does not exceed 2 cm^3 in volume.

NOTE

If criteria in step 2 cannot be met, consult NAVSEA.

3. No visible oil, grease, brazing flux, pipe dope or sealers, preservatives, or other foreign matter shall be on flush cloths, strainers, or in flush water.

505-7.7.7 PRESERVATION. It is important that only the proper preservation procedures, as indicated in the following paragraphs, be used for ferrous piping systems.

WARNING

Use safety precautions given in NSTM Chapter 631 as applicable.

505-7.7.7.1 To the maximum extent practical, prepare and coat piping in bilge areas as follows:

a. Remove rust, rust scale, and corrosion products by mechanical means (disc sanding, power or hand-wire brush, hand sanding, or other means, as available) to produce, if possible, a clean, moderately bright metal surface.

b. Use power tool (NSTM CHAPTER 631), if available, over the surface to the maximum extent possible to provide for the best adhesion of the coating. If the pipe wall is accidentally cut into, check the pipe thickness.

505-7.7.7.2 Where piping in the bilge areas is replaced, prepare the new piping as follows: abrasive-blast (with exception to feedwater and condensate system as described in paragraph 505-7.6.3.4) the external surfaces to near white metal per NSTM CHAPTER 631, volume 2 and Steel Structure Painting Council Structure Preparation Specification 10.

NOTE

If abrasive blasting equipment is not available, prepare pipe as indicated in paragraph 505-7.7.7.1 for existing pipe.

505-7.8 PIPING SYSTEM DESIGNATIONS AND MARKINGS

NOTE

For nuclear powered ships refer to NAVSEA S9AA0-AB-GOS-020, General Specifications for Overhaul of Surface Ships (GSO), Nuclear Supplement, Section 507 for piping designation and marking requirements.

505-7.8.1 GENERAL. Piping system designations and markings assist in training and troubleshooting and permit quick identification and proper system operation during casualty control. The designations and markings used on ships should conform to the descriptions provided in the following paragraphs. However, consult ship drawings for specific designations and markings.

505-7.8.2 COLOR CODING.

505-7.8.2.1 Surface Ship Piping. Surface ship piping located inside the ship shall be painted as indicated in table 505-7-1. Piping located in tanks and voids shall not be painted unless required by NSTM Chapter 631. Paint piping located on weather decks the same color as the surrounding structure.

505-7.8.2.2 Surface Ship Valve Hand wheels and Operating Levers. Handwheels and operating levers on valves located inside the ship should be color-coded per table 505-7-1. Handwheels and operating levers on surface ship reactor plant system valves are not color-coded except where specifically required by Government-furnished reactor plant drawings.

505-7.8.2.3 Submarine Valve Hand wheel. Submarine valve handwheels are plastisol covered using a color code similar to table 505-7-1. Solid colors are used in lieu of striped colors. Handwheels on gauge valves located on gaugeboards are not color-coded.

505-7.8.2.4 Shipboard Shore Connection Valves. Shipboard shore connection valve bodies, handwheels, and operating levers are not color-coded except as required by table 505-7-1. However, label plates or plain language markings should be provided that clearly indicate the service for each valve. This approach avoids potential conflicts between dockside shore connection and shipboard shore connection color codes for the same piping systems.

505-7.8.2.5 Gauge Valves. Operating levers on gauge valves located on gauge boards do not require color-coding. Operating levers on gauge root valves not located on gauge boards should be color-coded per table 505-7-1.

505-7.8.2.6 Surface Ship Valve Bodies. Valve bodies on valves exposed to the weather shall be color coded per table 505-7-1.

Table 505-7-1. COLOR CODE TABLE

Fluid	Color	FED STD 595 Color Number and Chip	Extent
Steam and Steam Drains	White	17886	Note A
Potable Water	Dark Blue	15044	Note A
Nitrogen	Light Gray	16376	Note A
Bleed Air	Green-gray	16555	Note A
Bleed Air Anti-icing	Striped green-gray/light blue	16555/15200	Note A
Bleed Air Masker	Striped green-gray/light yellow	16555/13655	Note A
Bleed Air Prairie	Striped green-gray/dark blue	16555/15044	Note A
Bleed Air Starting	Striped green-gray/orange	16555/12246	Note A
HP Air (1000 psig and up)	Dark Gray	16081	Note A
MP Air (above 150 psig and less than 1000 psig)	Striped dark-gray/tan	16081/10324	Note A
LP Air and Salvage Air	Tan	10324	Note A
Deballast Air	Striped Tan/Black	10324/17038	Note A
Oxygen	Green	14449	Note B
Seawater (other than fire main and sprinkling). Includes Main and Secondary Drainage, Waste Drainage, Distilling Plant Feed, Distilling Plant Brine Overboard, and Countermeasure Wash Down.	Dark Green	14062	Note A
JP-5	Light Purple	17142	Note B
Fuel	Yellow	13538	Note A

Table 505-7-1. COLOR CODE TABLE - Continued

Fluid	Color	FED STD 595 Color Number and Chip	Extent
Lube Oil (including PolyAlphaOlefin (PAO) electronic cooling)	Striped Black/Yellow	17038/13538	Note A
Foam Discharge Plugs (AFFF)	Striped Red/Green	11105/14062	Note A
Gasoline	Yellow	13538	Note B
Fresh water, Condensate, Feed, and Distillate (Submarines only)	Dark Blue	15044	Note A
Fresh water, Condensate, Feed, and Distillate (Surface Ships Only)	Light Blue	15200	Note A
Primary Coolant and Charging Water (Submarines only)	Light Blue	15200	Note A
Hydraulic	Orange	12246	Note A
Refrigerant	Dark Purple	17100	Note B
Hydrogen	Chartreuse	23814	Note A
Amine Dry Cleaning Fluid	Brown	10080	Note B
Helium	Buff	10371	Note A
Helium/Oxygen	Striped Buff/Green	10371/14449	Note A
Sewage	Gold	17043	Note A
Halon	Striped Gray/White	16187/17886	Note A
Fire Main (including root valves)	Red	11105	Note C
Chilled Water (Submarines only)	Dark Blue	15044	Note A
Chilled Water (Surface Ships only)	Striped Light Blue/Dark Green	15200/14062	Note A
Demineralized Electronic Cooling Water (Submarines only)	Dark Blue	15044	Note A
Demineralized Electronic Cooling Water (Surface Ships only)	Striped Light Blue/Dark	15200/17100 Purple	Note A
AFFF Concentrate	Striped Light Blue/Red	15200/11105	Note A
Access fittings (Submarines only)	Black	17038	
Carbon Dioxide (Submarines only)	Violet		Note A
Oil Pollution Abatement (OPA - Surface Ships only)	Black	17038	Note B and Note E
Jacket Water/Waste Heat	Striped Light Blue/Black	15200/17038	Note A
Divers life support system	Various	Various	Note F
AFFF Solution (concentrate/salt water mix)	Striped Red/Dark Green	11105/14062	Note D

SYMBOLS LIST:

Note A — Color code only valve handwheels and levers on valves not exposed to the weather. Valves and handwheels exposed to the weather (ship board shore connection) shall have label plates or plain language markings clearly delineate the service for each connection.

Note B — Color code valves bodies and handwheels exposed to the weather and all interior piping. Piping in tanks, voids, cofferdams and bilges shall not be color-coded.

Note C — All fire plugs and handwheels including associated components (strainer, wyegate, applicators, wrenches, and hose racks) shall be color-coded.

Note D — Color code all handwheels.

Note E — OPA piping in the bilge area shall be painted terra-cotta red (approximately chip 20152).

Note F — See NAVSEA 0994-LP-001-9010, Vol. 1 and 2, USN Diving Manual.

Table 505-7-1. COLOR CODE TABLE - Continued

Fluid	Color	FED STD 595 Color Number and Chip	Extent
GENERAL NOTES: 1. Valve handwheels and operating levers may be painted with brush or spray using enamel, Fed Spec TT-E-489, class A, where surface temperature does not exceed 180°F, but should not be applied in handwheels or levers where they could become immersed, such as in tanks and bilges. Handwheels and levers, where authorized by the Naval Commander also may be coated with plastisol per MIL-P-20689, type I, class 1. 2. If necessary, thin enamel or clean equipment using paint thinner per Commercial Item Description A-A-2904. 3. Surface preparation and priming for application of enamel per TT-E-489, shall be as specified in NSTM Chapter 631 for the applicable base material. 4. Surface preparation, priming, and application for plastisol per MIL-P-20689, shall be as specified in NSTM Chapter 631. 5. Because of potential flammability hazard with enamel per TT-E-489, safety precautions specified in NSTM Chapter 631 and OPNAVINST 5100.19, **Navy Safety Precautions for the Forces Afloat** , should be adhered to. 6. To clearly identify oxygen piping within a compartment, submarine oxygen system piping shall be painted dark green using paint in accordance with TT-E-489 and FED-STD-595, no. 14062.			

505-7.8.3 MARKING.

505-7.8.3.1 Pipe Marking. In addition to the color-coding required by table 505-7-1 for piping, mark all systems for identification. This marking shall include the functional name of the system. The functional name may be abbreviated using the standard damage control abbreviations found in NSTM Chap 079 Volume 2, Table 079-4. Where necessary for differentiation between two pipes of the same systems, include the specific service (see figure 505-7-14). As an example, mark plumbing drains, SOIL DRAIN, or WASTE DRAIN to suit the type of drainage carried in the pipe. In addition to the specific service, mark the system pressure and functional service; for example, 600 lb/in. ^{2} steam to forced draft blowers. For an outside diameter of 6 inches and larger (bare or lagged) pipe, apply markings that have 2-inch high letters. On pipes or lagging with a diameter between 2 inches and less than 6 inches, apply markings that have 1-inch high letters. For diameters less than 2 inches, use 3/8-inch high letters. The marking may be stenciled or applied using preprinted retro-reflective labels. Direction-of-flow arrows shall also be marked on the piping. As a minimum, one arrow must be placed immediately following the functional name. Additional arrows shall be placed at junctions and tees to indicate flow divisions. Flow arrows may be stenciled or applied using preprinted retro-reflective labels. Where pipe sizes are too small for lettering, wire label plates to the pipe inscribed with system name and, where necessary, the service; or band with material according to MIL-S-23190, **Straps, Clamps, and Mounting Hardware, Plastic and Metal, for Cable Harness** and MS-3367, **Strap, Tiedown, Electrical Components, Adjustable, Self-Clinching, Plastic, Type 1 Class 1** ; and install with hand tool according to MIL-T-81306, **Tool, Forming, for Adjustable Plastic and Metal Cable Straps.**

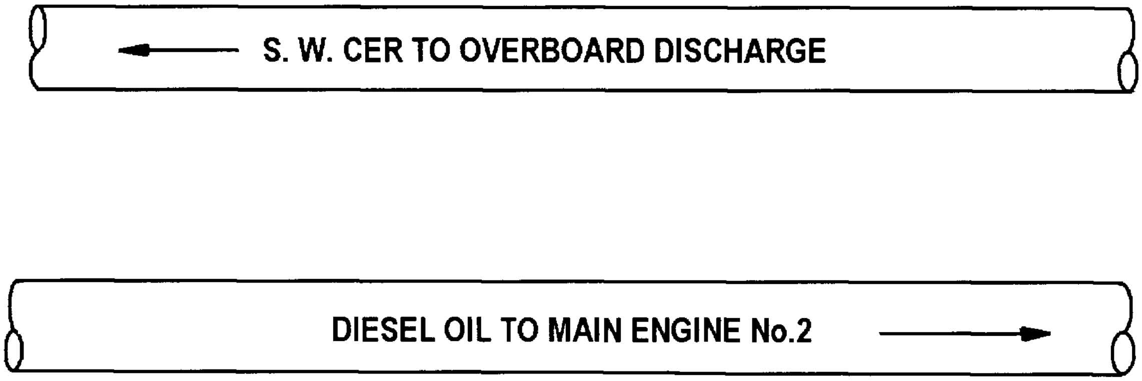


Figure 505-7-14. Pipe System Identification

505-7.8.3.1.1 Apply the marking using stencils and paint or commercially produced preprinted retro-reflective adhesive labels. All stenciled letters shall be black, with the exception of oxygen, which has white letters on black background. All labels will be black letters on a retro-reflective silver background.

505-7.8.3.1.2 Marking of piping located in tanks, voids, cofferdams, bilges, and similar unmanned spaces shall be by label plate curved to fit the piping and attached in place by full circumferential wiring or banding as described in paragraph 505-7.8.3.1. Attachment shall be such as to prevent movement of the label. Make the label plate of material compatible to both the pipe and the liquid contained in the space. Commercially produced preprinted retro-reflective labels may be utilized if the adhesive is compatible with the fluids that the label may encounter.

505-7.8.3.1.3 Markings shall be spaced not more than 15 feet apart, as measured along the run of piping, and shall be applied in conspicuous locations, preferably near control valves. Where piping is concealed behind sheeting, the markings shall be spaced not more than 5 feet apart, measured along the run of piping.

505-7.8.3.1.4 Piping that passes through spaces including unmanned spaces such as tanks, voids, cofferdams and bilges shall be marked at least once in each space. Piping in machinery spaces shall be marked at least twice, once near entry and once near exit. Systems serving propulsion plants and systems conveying flammable or toxic fluids shall be marked at least twice in each space. At the interconnection of systems, each system shall be marked nearby, wherever this is practicable. Where the service of the pipe is obvious, such as a short vent or drain from a tank, or where adjacent machinery, equipment, or valve marking makes pipe marking superfluous, marking is not required.

505-7.8.3.1.5 Where piping is behind protective battens, one label plate shall be attached to the batten that lists all piping located behind the batten. One label plate shall list all pipes installed in a pipe tunnel or similar space. Unless otherwise specified, or in special cases where the need is apparent, piping on weather decks does not require marking. Where marking of pipes on weather decks is required, it shall be by label plate.

505-7.8.3.1.6 When hull valves are not located on or near the sea chest, the piping shall be marked near the sea chest as specified in paragraph 505-7.8.3.1.

505-7.8.3.1.7 The method for marking deck plates for flush deck sounding pipes shall be as shown on NAVSHIPS DWG 810-1385848. For other types of sounding pipes, refer to NSTM Chapter 079 Volume 2.

505-7.8.3.2 Component Marking. All piping system components, including valves, should be provided with a label plate. Label plates may be located on the component or adjacent ship structure. Label plates generally contain a four-part designation and a basic location number. This applies to component identification and marking only. Refer to paragraph 505-7.8.3.1 for piping identification and marking.

505-7.8.3.2.1 Four-Part Designation. The four-part designation consists of the following:

1. Shaft or plant number, for valves located in a propulsion plant piping system.
2. System designation.
3. Component identification letters.
4. Individual component number. Individual component numbers are assigned in sequence starting at the origin or root connection of the system to its end point, excluding branch lines. The first component in the system is assigned the number 1, the second component 2, and so on, to the system end point. If a component is deleted from the system, its individual component number is not reassigned to any other component in the system. Similarly, if a component is added to a system it is assigned the next individual number following the last one assigned for that system.
   a. Surface individual component number suffix letters. Suffix letters are used to differentiate components located in surface ship piping systems that perform the same function, but are connected to separate plants; for example, turbine lube oil systems. The suffix letter is added to the end of the individual component number. It indicates which plant the component serves. Suffix letters start with the letter, A, and continue in alphabetic sequence. Suffix letters are not used for components located in propulsion plant piping systems; the plant or shaft code serves this purpose.
   b. Submarine individual component number suffix letters. A different approach is used in submarines. Instead of using suffix letters, the plant served is indicated by whether the individual component number is odd or even. Consecutive even numbers are assigned to components serving port plants; consecutive odd numbers are assigned to components serving starboard plants.
   c. Designation example. An example designation for a valve located in a surface ship main condensate system is: 1-MCN-V-15. Its meaning follows.
      (1) The number, 1, indicates that the valve is part of plant number 1 and that it is part of a propulsion plant piping system.
      (2) MCN indicates that the valve is located in the main condensate system.
      (3) V identifies the component as a valve.
      (4) The number, 15, indicates that the valve is the fifteenth component in the system.

NOTE

The shaft or plant number portion of the designation is not indicated if the valve is not located in a propulsion plant piping system. Component identification letters are not always marked.

505-7.8.3.2.2 Basic Location Number. Some component label plates will also be marked with a basic location code. A basic location code is a set of three numbers separated by hyphens. Basic location numbers indicate location of a component in the ship. An example of a basic location number is 2-34-45. Its meaning is given below.

1. The number, 2, indicates vertical location of the component in the ship by deck or platform level.
2. The number, 34, indicates longitudinal location of the component in the ship by frame number. If a component is not located on a frame, the next forward frame number is assigned, unless that frame is outside the compartment in which the component is located. In this case, the next aft frame number is assigned.
3. The number, 45, indicates transverse location of the component. Starboard locations are indicated by odd numbers, port locations by even numbers. Consecutive odd and even numbers are assigned as the components would be observed as being above, from forward to the next aft frame, and then outboard of the preceding component.

NOTE

Basic location codes should be marked on all valves that are part of Damage Control. See NSTM Chapter 079, Damage Control - Stability and Buoyancy, for additional information on damage control. They may also be found on valves that are not part of damage control. Where components, primarily valves, can be operated locally and remotely, the basic location number at both places of operation will be the basic location number of the component. Where components are located in tanks, voids, or other normally unmanned spaces, the basic location number will be the place of remote operation.

505-7.8.3.3 Miscellaneous Markings.

505-7.8.3.3.1 Where a valve is located below a deck plate or grating, or similarly hidden, the valve and the removable access plate should have a label plate.

505-7.8.3.3.2 Label plate marking on valves integral to equipment or machinery generally only indicate the valve functional service.

505-7.8.3.3.3 Valves located in manifolds should be individually marked.

505-7.8.3.3.4 Fire plug markings should include their functional service, the label FIRE PLUG, its basic location number, and the designation letter and basic location number of its cutout valve.

505-7.8.3.3.5 Button head machine screws are used to mark deck or hull operating stations for main compartment salvage-air system cutoff valves so that divers can locate the valves by touch.

505-7.9 FIRE HAZARD PRECAUTIONS FOR PIPING SYSTEMS

505-7.9.1 DEFINITIONS. Definitions of terms used in discussion of fire hazard precautions are given in the following paragraphs.

505-7.9.1.1 Hot Surface. For surface ships, a hot surface is a surface with a temperature of 205°C (400°F) or higher. For submarines, see paragraph 505-7.9.4.5.2. However, for lubricating oil and hydraulic oil systems, a hot surface is one having a temperature of 343°C (650°F) or higher. For insulated surfaces the temperature under the insulation is the reference temperature.

505-7.9.1.2 Fire Hazardous Areas. These are spaces where requirements for protecting flammable liquid hazards require CO_2 fixed flooding, fixed Halon 1301, Heptafluoropropane (HFP) or AFFF fire extinguishing systems. These spaces include:

1. Main machinery rooms
2. Auxiliary machinery rooms with fuel pumps or fossil-fueled equipment
3. Fire rooms and engine rooms of fossil-fuel powered ships
4. Propulsion engine enclosures
5. Electric power generator engine enclosures

6. Auxiliary fossil-fuel boiler rooms
7. Aviation storerooms (flammable)
8. Enclosed gasoline service stations
9. Flammable gas cylinder storerooms
10. Flammable liquid issue rooms
11. Flammable liquid storerooms and cargo holds
12. Fuel pump rooms (DFM, fuel, JP-5, LCAC, or MOGAS).
13. Paint mixing and issue rooms
14. RAST machinery rooms
15. Ship service or emergency generator rooms
16. Storerooms for gasoline powered bomb hoists
17. TACTAS handling rooms
18. Hangars

505-7.9.1.3 Fire-Hardened Fittings (For Surface Ships Only). These are fittings which are welded, or which comply with ASTM F-1387, including satisfactory accomplishment of fire testing and are approved by NAVSEA for the intended application.

505-7.9.1.4 Auxiliary Machinery Space Spray Shields. When determining the need for spray shields, the spaces listed below are considered auxiliary machinery spaces in addition to those specifically designated as auxiliary machinery spaces on the ship general arrangement drawings:

1. Spaces containing oil-fired auxiliary boilers or incinerators
2. Spaces containing emergency gas turbine or diesel-engine-driven generators/fire pumps
3. Other spaces containing steam piping at main steam pressures.

NOTE

JP-5 pump rooms and aircraft refueling stations are not considered auxiliary machinery spaces. Requirements for these spaces shall be in accordance with areas outside main and auxiliary machinery spaces, paragraph 505-7.9.4.5.3 and paragraph 505-7.9.4.5.4.

505-7.9.2 PIPING JOINTS (FOR SURFACE SHIPS ONLY). Many shipboard fires are hot enough to melt the brazing alloy that holds brazed joints together, leading to leakage of system fluid. Leakage of the fluids listed below can contribute to the severity of the fire or impair the ability of ship's force to contain it. See section 6 for Welding and Mechanically-Attached Fitting (MAF) alternatives.

505-7.9.2.1 Fire-hardened fittings are required and brazed joints are prohibited throughout the ship in the systems listed below:

1. Fuel
2. Lubricating Oil
3. Hydraulic Oil (steel and CRES piping)
4. Gasoline
5. JP-5
6. Air (Steel and CRES piping and 6000 psi CU-NI)
7. Gaseous Oxygen (NI-CU piping)
8. Liquid Oxygen, Mixed Gas (CRES piping)
9. Sprinkling System (dry)
10. Magazine Sprinkling System (wet)
11. AFFF and AFFF/Seawater
12. Halon and Halon Actuation
13. Fuel Stripping

505-7.9.2.2 Fire-hardened fittings are required and brazed joints are prohibited in the systems listed below, where piping is located within compartments which are served by CO_2 fixed flooding, Halon 1301, Heptafluoropropane (HFP) or AFFF fire extinguishing systems.

1. Hydraulic Oil (Cu and Cu-Ni piping)
2. Contaminated Aviation Lube Oil
3. Air (Cu and 6000 psi Cu-Ni piping)
4. Gaseous Oxygen, Liquid Oxygen, and Propane (Cu and Cu-Ni piping)

505-7.9.2.3 Fire hardened fittings are required in miscellaneous seawater sprinkling system piping when is out side of spaces which are wet-sprinkled.

505-7.9.3 PIPING ARRANGEMENT. The piping arrangement for fire safety is:

1. Flammable fluid piping is not to be located within 18 inches of hot surfaces, even when surfaces are insulated.
2. Piping with hot surfaces is not to be located within 18 inches of tanks containing flammable fluid, even if they are insulated.
3. Flammable fluid piping is not to be routed through the spaces listed below, except to serve equipment in the spaces. If waivers are given to this requirement, do not install takedown joints in the spaces affected.
   a. Motor rooms
   b. Generator rooms
   c. Switchboard rooms
   d. Electrical, electronic, weapons control, or interior communications rooms
   e. Oxygen-nitrogen producing rooms, stowage rooms, and fill rooms

f. Liquid oxygen stowage spaces.

4. Flammable fluid piping is not to be routed through uptake spaces, catapult steam trunks, and voids.

5. Flammable fluid piping is not to be located over hot surfaces.

505-7.9.4 SPRAY SHIELDS. Spray shields prevent an oil spray or the release of an atomized mist from a joint. Leaks will be evidenced by oil dripping from the bottom of the shield. Repair all leaks immediately.

505-7.9.4.1 Fabrication. Fabricate spray shields in accordance with NAVSHIPS Drawing. No. 803-2145518 or ASTM F-1138. Illustrative information contained in the ASTM standard is repeated in figure 505-7-15. Limit thread stitching used to sew the shield to only those seam areas depicted in the ASTM standard. Locate the sewing so that when the shield is installed, needle penetrations and stitching will not be situated over the periphery of the joint. The fiberglass thread required by ASTM F-1138 sometimes breaks in sewing machines. In those cases, nylon thread is an acceptable substitute. However, fiberglass thread has better flame resistance and should be used when feasible.

505-7.9.4.2 Installation. Install spray shields to cover the perimeter of the flanged joint with an overlap sufficient to achieve complete enclosure. The side overlap will extend down to cover the bolts and nuts of the bolt circles on either side of the joint. Tightly pull and securely fasten the side drawstring so the bolt circles are overlapped completely. This may or may not bring the shield into contact with the pipe. In cases where joints are butted against machinery, such as lube oil piping flanges mounted on reduction gear casings, tightly secure the shield to the flange by fitting a metal band or hose clamp arrangement around the shield, and over the perimeter of the flanged joint. Pull the wire drawstring tight.

NOTE

Use of adhesive tape is no longer authorized for spray shield installation.

505-7.9.4.3 Inspection. Inspect spray shields quarterly to ensure that they are tightly secured and that they are not damaged to the point where they are unable to contain oil spray. Take care to protect shields from abrasion or tearing. Shields do not require painting; avoid such practice. However, do not replace shields that have already been painted on that basis.

505-7.9.4.4 Supply Stock. Bulk shield stock and thread are available under the following stock numbers:

1. Silicone-coated glass outer cloth with two layers of aluminized glass cloth, 50 yards by 48-inch roll: NSN 4730-00-085-1715.

2. Fiberglass thread, left-hand twist, 2-pound spool: NSN 4730-00-085-1711.

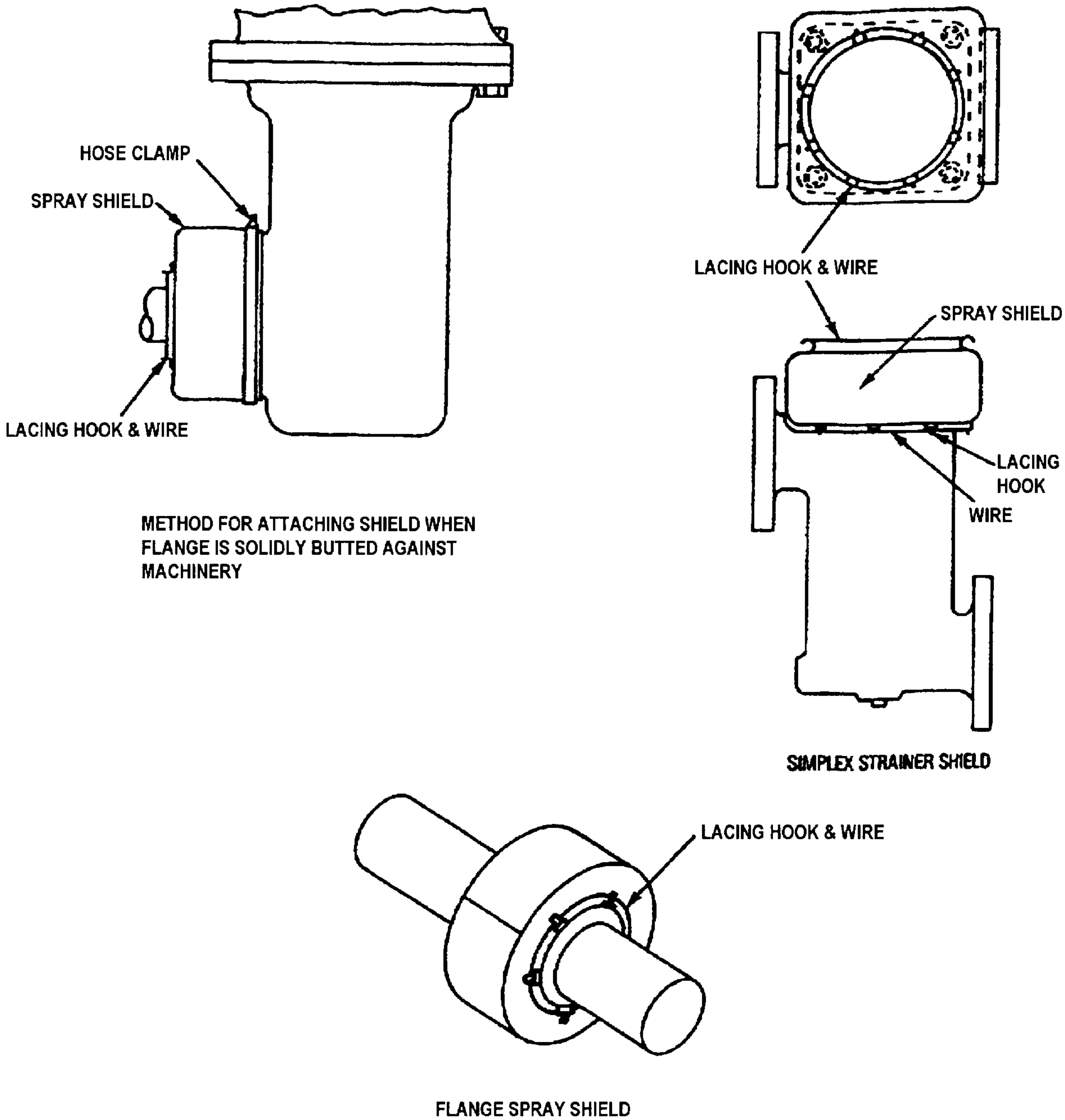


Figure 505-7-15. Approved Spray Shield installations (Sheet 1 of 2)

3. Nylon thread, Z-twist, 3 ply, 500 yd spool: NSN 8319-00-248-9715.

505-7.9.4.4.1 Prefabricated shields in the widths indicated are available under the stock numbers given in table 505-7-2.

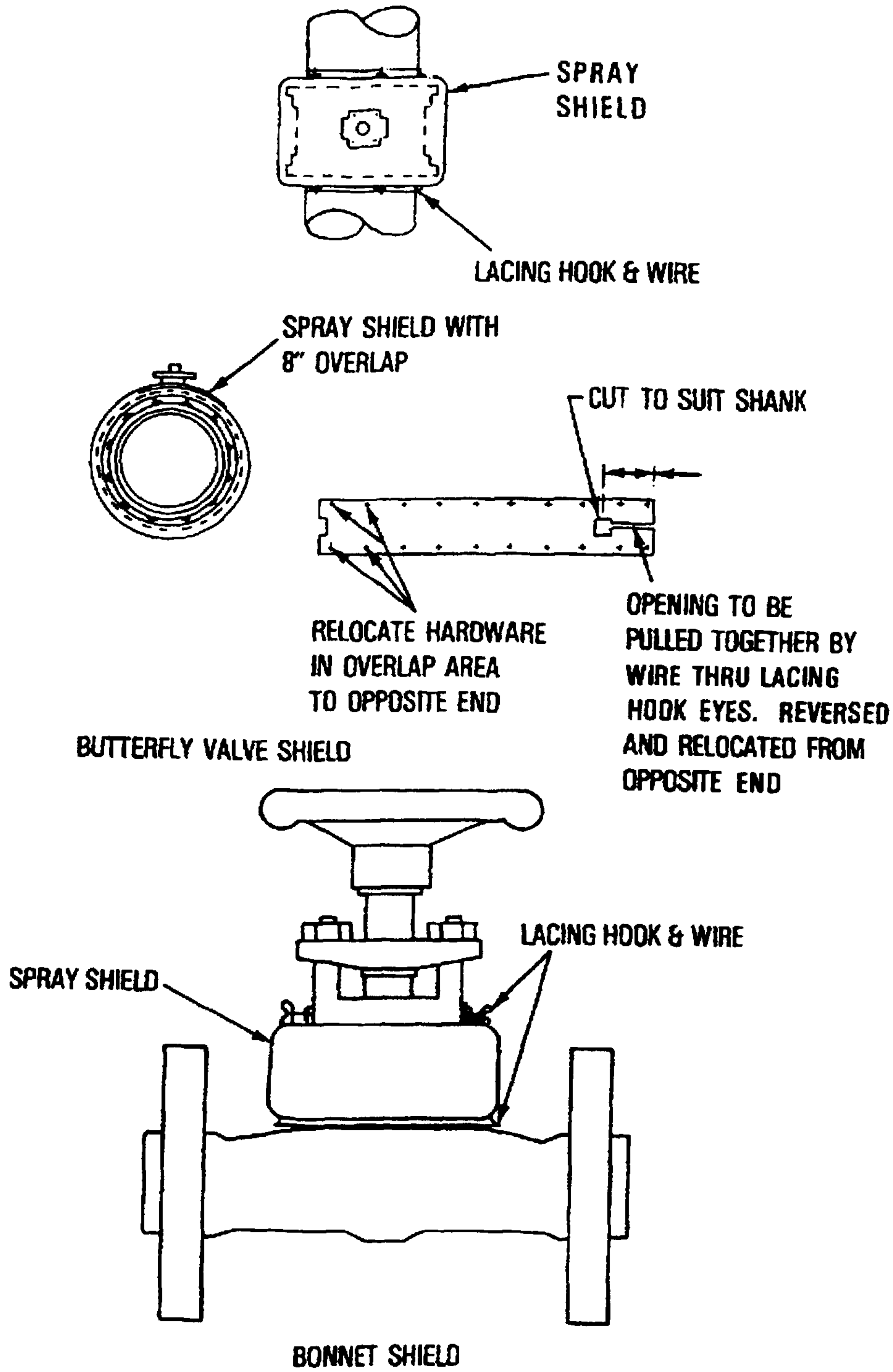


Figure 505-7-15. Approved Spray Shield Installations (Sheet 2 of 2)

505-7.9.4.5 Requirements. For main and auxiliary machinery spaces on fossil-fueled surface ships, provide spray shields for flanged joints (including simplex strainer flanged covers) and flanged valve bonnets in piping containing flammable fluid.

Table 505-7-2. PREFABRICATED SPRAY SHIELDS - NSN

Width (in.)	Length (ft)	NSN 4750-01-010
5	30	-0997
6	30	-0998
7	30	-0999
8	30	-1000
9	20	-6123
10	20	-1001
11	20	-1002
12	20	-1003

505-7.9.4.5.1 The requirements for spray shields for main and auxiliary machinery spaces on nuclear-powered surface ships are:

1. Provide spray shields for flanged joints and flanged valve bonnets in piping containing lubricating oil and hydraulic fluids located in the direct plane of, and 10 feet or less from an electrical switchboard, electrical equipment enclosure, or motor.

NOTE

Protection is not required for watertight, spraytight, totally enclosed, submersible, or explosion-proof electrical equipment.

2. Provide spray shields for flammable fluid piping other than lubricating oil and hydraulic oil according to the requirements of paragraph 505-7.9.4.5.

505-7.9.4.5.2 On nuclear powered submarines, spray protection shall be provided to prevent fire or loss of propulsion due to liquid spray resulting from the failure of the sealing medium of an unlagged mechanical joint meeting the criteria below:

a. Flammable Liquid Systems: Spray shields shall be installed on any unlagged mechanical joint in piping containing flammable liquid which is pressurized during normal submerged operation if the joint is within 10 feet of an electrical component or hot surface. Diesel fuel, lube oil, and hydraulic oil are all considered flammable. A ″hot surface″ is one whose temperature exceeds 400°F, unless the flammable fluid is lube oil or hydraulic oil. For lube oil and hydraulic oil, a ″hot surface″ is one whose temperature exceeds 650°F, and submarine steam piping temperature is below 650°F.

b. Non-Flammable Liquid Systems: O-Ring, flat sheet type gasket and metal to metal joints. Spray shields shall be installed on any unlagged mechanical joint in piping normally pressurized in exesss of 200 psig that is within 10 feet of a non spray protected electrical component.

c. If it is not known whether an electrical component is spray protected, the following visual inspection can be used: Use a light to inspect, from the outside, through any open hole or louver. If any electrical piece, part or component is visible inside the enclosure or case, consider the component non spray protected for the purpose of spray shield application.

d. For purposes of installing spray shields, electrical components are defined as switchboards, instrument panels and benchboards, electrical controllers, instrumentation cabinets or other equipment where wetting could result in fire or loss of propulsion.

e. NAVSEA DWG 803-2145518 or ASTM F1138 shall be used as the standard for fabrication of spray shields.

f. Exclusions: Spray shields are not required on the following mechanical joints:
   1. Gage lines
   2. Spiral wound flexible metallic gasket joints
   3. Union nuts, including valve bonnets secured by union type nuts
   4. Steam, gas or air system joints
   5. Lagged joints
   6. Joints protected by shipboard barriers such as lockers, decking and foundations
   7. Flanges which are self-shielded (for example, a lip) outside the gasket and the gasket is positively captured. (NAVSHIPS DWG 803-2177525 valves and 845-2050869 flanges, for example.)

g. For SSN 688 and SSBN 726 class submarines, spray shields installed by the ″as built″ drawings shall not be eliminated during overhaul availabilities. The above criteria shall be used when installing new spray shields on these two classes of submarines.

505-7.9.4.5.3 For areas outside main and auxiliary machinery spaces, provide spray shields for flammable fluid piping flanged joints; and flanged valve bonnets located in the direct plane of an electrical switchboard, electrical equipment enclosure, or a motor. Protection is not required for watertight, spraytight, totally enclosed, submersible, or explosion-proof electrical equipment.

505-7.9.4.5.4 Spray shields are not required for the following:

1. Piping not subject to pump discharge pressures; for example, lube oil, storage tank gravity fill lines and pump suction piping that cannot be pressurized through a cross-connection with or as part of the operation of another system
2. Piping located in voids or cofferdams
3. Bilge pump discharge piping, except where the pump is part of a tank stripping system
4. Tank sounding tubes, air escapes, vents, and overflows
5. Gauge line piping downstream of a root valve, except for flanged connections
6. Piping located inside gas-turbine modules and gas-turbine generator reduction gear enclosures
7. Joint located within metal shielding enclosures for duplex strainers
8. Piping on weather decks
9. Piping below floor plates except on fossil-fueled steam ships
10. Self-shielded flanges where the gasket is positively captured. As an example, the flanges on valves per NAVSEA DWG 803-2177525 have a lip outside the gasket. Valves per NAVSEA DWG’s 803-5001003 and 803-5001004 also meet this criteria.
11. Union and union-type fittings.

505-7.9.5 SAFETY SHIELDS. Safety shields for fuel and lube oil duplex strainers shall be in compliance with the design guidance of NAVSEA 0948-LP-102-2010, **Fuel and Lube Oil Strainer Safety Shield Design Guidance** , except for lube oil strainers for steam-turbine-driven machinery in nuclear-powered ships that do not require shielding because of the absence of hot surfaces 343°C (650°F) or higher. Additionally, limit shielding to those duplex strainers that are subject to pump pressure.

505-7.10 GRAVITY DRAIN SYSTEM FUNNELS

505-7.10.1 BACKGROUND. Funnel splash/overflow can cause serious corrosion of adjacent pipes and structures. The following paragraphs provide general guidance for reduction of funnel splash/overflow. Additional detail is available on NAVSEA drawing 804-6829843, **Repair Methods for Gravity Drain System Funnels** . This drawing is available from Puget Sound Naval Shipyard.

505-7.10.2 PRECAUTIONS. Gravity Drain Systems, whether existing, or modified in accordance with any of the following paragraphs, must always meet the following criteria:

1. Not less than 1/2 inch air gap between the bottom of the drain source pipe and the mouth of the funnel (to prevent potential siphoning and ensure sound isolation).
2. Adequate clearance between funnels and surrounding equipment to account for shock excursion of any resiliently-mounted equipment.
3. All funnels, pipes, and hangers must be in accordance with applicable piping arrangement drawings. Any deviations must be approved by the cognizant Planning Yard via LAR (Liaison Action Request).

505-7.10.3 INSPECTION. The following inspections should be carried out on splashing/overflowing funnels:

1. Alignment. Check that drain source pipes and funnels are properly aligned. (Simply bending small-diameter piping may resolve splashing caused by misalignment).
2. Obstructions. Check that funnel screens are clean and free of debris and that funnel drain pipes are free of obstructions.
3. Slope. With the ship at even keel, check that all drain piping leading from the funnel has a downward slope.
4. Capacity. If inspection reveals no misalignment, obstructions, or improperly sloped piping, the funnel may be too small for the number of drain sources it services.

505-7.10.4 MODIFICATIONS. The following modifications may be used to correct funnel splash/overflow.

1. Tygon Tubing. The installation of Tygon tubing on a drain source pipe may be used to redirect a misalignment or shorten an excessive gap. The following guidelines apply to the use of Tygon tubing:
   a. Tygon tubing should not be used for the discharge of steam or for high-velocity discharges (e.g. relief valve discharges).
   b. The inside of the Tygon tubing must of slightly larger diameter than the drain source pipe.
   c. Tygon tubing should be fixed with a hose clamp, with at least one-inch engagement onto the drain source pipe.
   d. If it is necessary to shorten the drain source pipe in order to route the Tygon Tubing without kinking, this must be done below the last support hanger. Where the last hanger is too close to the end of the drain source pipe, it may be necessary to relocate the hanger. Where the relocation or redesign of a hanger is necessary, concurrence from the Planning Yard is required.
   e. It may be necessary to maintain the alignment of Tygon tubing with ties to an adjacent ″hard″ drain source pipe.
   f. Tygon tubing should be visible and not hidden by an adjacent drain source.

2. Funnel Enlargement. Where an existing funnel cannot handle the drainage volume, or where too many drain source pipes are crowded into the existing funnel to allow proper alignment of all pipes, an enlarged funnel may be required to avoid splash/overflow. Where allowed by available space and surrounding equipment, either increase the size of the existing funnel by brazing, riveting, or screwing on extensions, or replace with a new and larger funnel.
3. Funnel Flap Assembly. Installation of a funnel flap assembly where space permits is considered the most acceptable method for containing splashing and a constant or uncontrolled mist or vapor. The funnel flap assembly is also desirable for gravity drains that are subject to a vacuum and where space limitations do not allow for enlarging a funnel. Funnel flap dimensions must be such that the flap bottom does not create a seal with the interior of the funnel. This is to prevent the potential siphoning of fluids in funnels where drain sources are subject to vacuum conditions. Prior to using the funnel flap design in an application where a vacuum potential exists, concurrence from the Planning Yard is required via Liaison Action Request (LAR). The following information should be provided on the LAR: Identification of funnel, drain sources, existing dimension from bottom of drain sources to funnel top for each source, and a sketch showing the available space above the funnel for installing the funnel flap design. See NAVSEA drawing 804-6829843, **Repair Methods for Gravity Drain System Funnels** for additional information on this method.
4. Strainer Box Type Funnel. The use of strainer box type funnels is the most effective method of containing the overflow, splashing and constant mist of vapor emitting from some drain sources. However, they are costly and more complex to fabricate. The use of the strainer box type funnel is recommended for use where other modifications are not feasible and space permits. See NAVSEA drawing 804-6829843, **Repair Methods for Gravity Drain System Funnels** for additional information on this method.
5. Realignment of Drain Source Pipe. Where misalignment cannot be corrected by installing Tygon tubing and/or enlarging the funnel, cut out and remove the section of drain source pipe required, and replace with new drain source pipe with adequate length and bends to provide correct alignment.

505-7.10.5 SAMPLE DRAINS. Where excessive splashing occurs from a drain source pipe used as a sample point because of its height above the funnel, Tygon tubing may be attached to lower the effective drain source height while still allowing sampling.

SECTION 8
PIPING REPAIR

505-8.1 GENERAL

505-8.1.1 INTRODUCTION. This section covers general repair procedures for piping systems. Early detection and correction of defects will reduce the amount of effort required for repair and will provide improved operating conditions.

CAUTION

Ensure proper fasteners are used in accordance with NSTM Chapter 075, Threaded Fasteners.

505-8.2 SAFETY PRECAUTIONS

WARNING

Ensure fasteners are of proper material. Black oxide coated brass can be mistaken for steel. Refer to NSTM Chapter 075 for more details.

505-8.2.1 HYDRAULIC SYSTEMS. Consult NSTM Chapter 556, Hydraulic Equipment (Power Transmission and Control), for hydraulic system isolation safety precautions.

505-8.2.2 SYSTEM AND EQUIPMENT ISOLATION WHEN CONDUCTING MAINTENANCE AND TESTING. A pressure barrier prevents the escape of a pressurized fluid from a system or from one part of a system to an adjacent part of a system. Pressure barriers are necessary when conducting maintenance on piping systems so as not to endanger personnel and equipment. These dangers include personnel injury due to high-temperatures, escape of flammable fluid and impingement on hot surfaces resulting in a fire, displacement of breathable air, toxic gasses, projectiles from high-pressure systems, wetting of electrical equipment, or unintentional venting or draining of adjacent systems. Specific requirements of onboard systems, component operating and technical manuals should be observed.

WARNING

Relief valves that are gagged for use as pressure barriers must be ungagged prior to system startup so that proper overpressure protection is provided.

505-8.2.3 PRESSURE BARRIER COMPONENTS. When isolating piping for component repair or replacement, the type of pressure barrier used for isolation is an important consideration and shall be in accordance with NAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL.**

505-8.2.4 TWO-BARRIER PROTECTION. There shall be at least two pressure barriers between the maintenance area and any high-temperature (200 degrees F or more) fluid, high-pressure gas (1000 psi or more), oxygen at any pressure, hazardous (toxic fumes) fluid, or flammable fluid in accordance with NAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL.**

505-8.2.4.1 Valves. It is preferable to have valves versus blind flanges accomplish two-barrier protection for high-pressure (1000 psi or more) compressed gas, toxic gas, and steam systems.

505-8.2.4.2 Steam Systems. Ships built to Navy specifications are provided with two-valve protection from any steam main common to other boilers. Two-valve protection can be furnished by the two valves in the system closest to the boiler. Test connections or valved drain lines are provided between these valves to provide a telltale indication of isolation valve leakage and to alert watchstanders to a potentially dangerous situation. Where telltale leak indicators are used, they are to be monitored by maintenance personnel. If this is not possible, a separate watch is to be provided.

505-8.2.4.2.1 Each branch steam line to auxiliary machinery or equipment on a ship should be provided with a root valve at the supply main, in addition to the control or throttle valve at the unit served. Where the throttle valve is not provided with means for positive closure, or where it is built into the equipment, an additional cutout valve adjacent to the machinery or equipment should have been installed during construction. These provisions permit safe maintenance or repair of the equipment or machinery without requiring shutdown of the associated steam system.

505-8.2.5 TAGGING-OUT. A potential danger in piping system repair lies in inadvertent or accidental operation of the isolation valves. Tag-out in accordance with NAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL** all isolation valves and their controls, local and remote, to prevent inadvertent operation. For flammable fluids, remote operators should be disconnected and restraining devices should be placed on all valves that are tagged out. On isolation valves which have electrical actuators, remove the fuses from the actuator circuit or disconnect the electrical connector from the actuator so that the valve cannot be accidentally opened. If a valve is air-hydraulically operated, shut (tag out in accordance with VAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL**) the actuator air hydraulic supply isolation valves so that the valves cannot be accidentally opened. See VAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL** , for additional information regarding shutting and tagging-out valves.

505-8.2.5.1 Valve Alignment. When piping is under repair, secure and tag-out in accordance with NAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL** .

505-8.2.6 INITIAL PROCEDURES FOR OPENING LINE JOINTS AND VALVE BONNETS. Before opening a line joint or valve bonnet, or cutting into a line, perform the following steps:

a. Obtain replacement parts and required tools prior to disassembly of any component.

b. Tag-out the isolating valvesin accordance with VAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL** .

c. Provide any compartment that contains a fluid energy accumulator (or to which a large volume of fluid energy can be released) with two-barrier protection if the released volume, in standard cubic feet, is twice the compartment volume.

d. Provide two-barrier protection if the fluid in the on-line portion of the piping system is high-temperature (200 degrees F or more), oxygen, toxic, or flammable (see paragraph 505-8.2).

e. Depressurize and drain the isolated portion and leave it vented during the entire repair period. Establish how to depressurize entire system in case the isolation valves/barriers fail during maintenance operation.

f. Take precautions to prevent fire or explosion of flammable fluid. This includes installing temporary shielding around work areas where flammable fluid leakage could come in contact with hot surfaces/electrical equipment. Also, provide a fire watch when flammable fluid is involved.

g. Determine if the unisolated portion of the system is pressurized. If it is unpressurized, verify that its condition will not change during maintenance.

h. Provide adequate ventilation.

505-8.2.6.1 Opening Flanged Joints. When opening flanged joints, two diametrically opposed securing nuts shall remain tight while the remainder are loosened. Then loosen these two nuts sufficiently to permit opening the joint. After the joint is opened and the line or valve is proven clear, all nuts may be removed. If the flange is being opened to vent or drain a portion of the system for maintenance, the nuts shall not be removed.

505-8.2.7 PROTECTION OF ELECTRICAL EQUIPMENT. Before working on any piping system, survey the maintenance area to ensure that liquids cannot splash on exposed electrical equipment under any conditions. If there is any possibility of splashing a switchboard or other electrical equipment, take the following steps:

CAUTION

Do not deenergize electrical equipment without approval of the duty officer.

a. Deenergize electrical equipment and cover with a waterproof material.

NOTE

If it is not possible to deenergize the electrical equipment before work on the piping system begins, completely cover the equipment with a rubber sheet or other nonconductive waterproof material. Do not restrict ventilation to the point that equipment will overheat.

b. Open piping away from electrical equipment, at a lower level if feasible, to ensure that the line is completely drained and unpressurized.

505-8.3 LEAKAGE

505-8.3.1 GENERAL. Actions to stop leakage should be performed immediately. If allowed to persist, the leaks will become progressively worse and may eventually cause a blowout. In addition, flange faces in high-pressure joints will become cut and require rebuilding and refacing.

WARNING

Before increasing the torque on flanged joint bolting to stop or reduce leakage, de-pressurize the piping.

CAUTION

When increasing the torque on flanged joint bolting, ensure that the bolting is not over stressed.

505-8.3.2 RECURRING LEAKAGE. When continuing or repeated leakage occurs in a piping system, determine and correct the cause. Common causes are:

1. Flange face misalignment
2. Flange face finish damaged
3. Inadequate allowance for thermal expansion, rapid temperature changes, working of the ship, and other movements
4. Vibration
5. Hydraulic transients (water hammer)
6. Corrosion
7. Erosion
8. Gaskets, O-rings, sealants damaged
9. Improper fasteners/material such as those weakened because of diverse temperatures or environment.

505-8.3.3 THREADED CONNECTIONS. Inadequate preload, damaged seals, and sealing face misalignment are common causes of leaking threaded connections. Disassemble the connection and inspect the seal, sealing surfaces, and threads for damage. Repair the sealing surfaces as required and replace the seal. See paragraph 505-6.4.2 for sealing surface finish requirements. Actions to repair damaged threads are provided in table 505-8-1. Sealing face alignment is discussed in paragraph 505-7.4.1. Reassemble the connection and preload it to the specified value. Consult ship drawings or equipment manuals for required torque/preload. Where this information does not exist, refer to NSTM 075 for guidance.

505-8.3.3.1 All surface ships and suface ship equipment originally fitted out with tapered pipe threaded connections in flammable liquid piping systems, which are in good repair, (not showing any visible signs of deterioration or leakage) should not be disturbed. When installing new piping, modifying or renewing piping (replacing nonserviceable or nonrepairable piping), or performing class A or B overhaul of components in flammable liquid piping service systems on surface ships fitted with tapered pipe threaded connections, the connections shall be seal brazed or welded, or mechanically locked or sealed, or replaced with connections per MIL-STD-777 (straight threads with O-rings). Where approved, the connections can be replaced with heat recoverable couplings, swaged marine fittings, or lockring fittings. An aerobic thread locking compound (Loctite) or locknuts with seals are approved methods for obtaining a mechanical lock and seal.

505-8.4 CLEANLINESS

505-8.4.1 System cleanliness shall be maintained during repair. Place caps or temporary blind covers over open piping to prevent entry of debris. Remove all foreign material such as paint, heavy scale, grease, or other contaminants for at least 6 inches on each side of the repair area. It is not necessary to polish the piping. The piping should be clean, dry, and free of solvents and flammable vapors. Steam plant systems on nuclear powered ships should be maintained in accordance with the requirements of NAVSEAINST 9210.36, Steam Plant Cleanliness Control, or NAVSEA 0989-064-3000, Cleanliness Requirements for Nuclear Propulsion Plant Maintenance by Forces Afloat.

505-8.5 CRACKS

505-8.5.1 Pipe or tubing requiring repair may show cracks or other defects indicative of incipient failure. In repair areas where such defects are suspect as a result of visual inspection, liquid-penetrant or magnetic particle test the area. Cracks are not permitted. Repair/replace the affected pipe or tube and hydrostatically test as required.

Table 505-8-1. THREAD LEAK CAUSES AND CORRECTIVE MEASURES

Causes of Trouble	Corrective Actions
Rough Threads:	
Dull thread chaser	Sharpen
Insufficient lubrication	Add more oil
Improper lead shape	Grind properly
Excessive or insufficient lead cutting	Grind to correct angle
Broken tooth in chaser leader	Grind out entire tooth
Chaser not set to form true cutting circle	Clean slots, set chasers to true cutting circle, grind chasers if necessary to a uniform depth
Shaved Threads:	
Improper chaser lead	Regrind lead
Chasers not tracking properly	Keep slots clean
Chasers not set in correct rotation	Correct setting
Carriage travel retarded (machine only)	Repair carriage
Wavy Threads:	
Die or chasers not true (manual only); loose chasers (machine)	Center die or chaser, add new die head
Thumb screws not tight (manual only); worn cam in head (machine)	Tighten with wrench, add new die head
Worn-out lead screws (manual only)	Get new die stock
Cuttings or dirt in chaser slots (manual only)	Keep slots clean
Shoulders:	
Pipe ends not square (manual only)	Recut square and rethread
Die and chuck not aligned (machine)	Check and realign

505-8.6 TEMPORARY OR EMERGENCY REPAIRS

505-8.6.1 DAMAGE CONTROL. NSTM Chapter 079, Volume 2, **Damage Control - Practical Damage Control** , describes various pipe repair methods for damage control procedures. These methods may be used for making temporary or emergency repairs to piping. However, safety, isolation, and tag-out (in accordance with S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL**) procedures must still be followed.

505-8.6.2 PIPE AND TUBE REPAIR. Small holes may be repaired by drilling and installing a rivet, or by drilling and tapping a threaded hole and installing a screw. Larger holes may be repaired by placing a suitable gasket (soft patch) over the opening and holding the gasket in place by:

1. Wrapping with marlin or wire
2. Metal straps
3. Sheet metal collar, similar to a hose clamp, secured with nuts and bolts.

505-8.6.2.1 Preferably, the gasket shall be of the same material used for flange gaskets. A suitable sealing compound may be applied between the gasket and pipe to assist in obtaining a tight seal. Permanently repair piping as soon as possible.

505-8.6.3 METALLIC PIPE REPAIR KIT. The Emergency Damage Control Tension Clamp Kit. The tension clamp kit contains materials and instructions for repair of small leaks in systems with high temperature and/or pressure. This kit consists of NSN 1H4730-01-400-3662X3. It is described in NAVSEA 389-0317, section 13.

505-8.7 SEMI-PERMANENT REPAIRS

505-8.7.1 WIRE WRAPPING. The piping may be wrapped tightly with wire and soldered or brazed as it is applied. Several layers of wire, securely bonded, give a strong, tight repair.

505-8.7.2 SOFT METALS. Form a sheet metal mold, filled with fire clay, completely around the piping at the leak areas. Place the piping in a vertical position and fill it with water above the level of the leaks. The water minimizes thermal movement of pipe during the repair. Pour a molten mixture of available soft metals, such as babbitt or zinc, into the mold to fill the holes.

505-8.7.3 REPLACE SEMI-PERMANENT REPAIRS. Permanently repair piping as soon as possible.

505-8.8 PERMANENT REPAIRS

505-8.8.1 GENERAL. Permanent repair for most piping systems consists of replacing the affected piping sections. However, piping made from copper or brass may be permanently repaired as discussed in paragraph 505-8.8.2.

505-8.8.2 COPPER AND BRASS PIPING. Repair copper and brass piping as described in the following paragraphs. This does not include 70-30 or 90-10 copper-nickel alloy.

505-8.8.2.1 Small Leaks. Repair small leaks in copper or brass piping by brazing.

505-8.8.2.2 Large Leaks. Larger leaks in copper or brass piping may be repaired by brazing a patch over the hole as follows:

a. Prepare a repair patch. It shall be made from the same material and have a thickness at least equal to that of the piping requiring repair.

b. Thoroughly clean the surfaces to be brazed together with file or emery cloth, then coat with flux.

c. Securely wire or clamp the patch in place.

d. Build screening walls with fire brick, Naval Sea Systems Command (NAVSEA) approved asbestos-free sheet material, or similar material to confine the heat to the vicinity of the place to be brazed.

e. Apply sufficient heat with an acetylene torch to melt brazing alloy; take care not to burn the piping.

f. Feed brazing alloy between the surfaces to be brazed until it has run between all parts of the patch. The brazing alloy is applied from inside or outside the piping, according to circumstances. Allow the work to cool slowly.

NOTE

For further information, see **NSTM Chapter 074, Volume 1, Welding and Allied Processes** .

505-8.8.3 WELDING REPAIR. Procedures for repair of piping leaks by welding shall comply with the same requirements as joining new piping by the welding process. Reference the applicable sections of this chapter; NAVSEA S9074-AR-GIB-010/278, **Requirements for Fabrication Welding and Inspection, and Casting Inspection and Reair for Machinery, Piping, and Pressure Vessels** ; and other pertinent documents.

505-8.9 RENEWING PIPING

505-8.9.1 When replacement of a section of piping is required, the procedures for installing the new section shall be according to ship drawings or the portions of this chapter pertaining to the installation of new piping. The material in the new section shall be the same as that used in the remainder of the system unless otherwise approved; for example, older ships with steel fuel service systems can have stainless steel replacement pipe to reduce corrosion problems. For diesel fuel systems, do not reduce fuel pipe size or add new restrictions, such as filters, without carefully recalculating the line losses. Diesel injectors rely on extreme excess fuel flow for proper cooling.

NOTE

Do not use copper or copper-nickel as a substitute in diesel engine fuel lines regardless of the type of end fittings used. Copper ions entering the fuel will plate out on the diesel engine injectors.

505-8.10 RESHAPING COPPER PIPING AND TUBING

505-8.10.1 GENERAL. Copper piping and tubing sections that have been dented, flattened, or distorted may be brought back to normal roundness and shape by the method described in paragraph 505-8.10.2 through 505-8.10.2.7, which eliminates hammering to achieve the desired shape. This method may locally anneal the copper material and should not be used in systems where bulged piping has been a recurrent problem. For other materials such as copper-nickel, an engineering evaluation should be performed prior to using this method. If the engineering evaluation is satisfactory, approval of a departure from specifications should be requested.

505-8.10.2 RESHAPING. The following paragraphs describe the considerations involved in dent removal by application of heat. This procedure provides for use of oxyacetylene heat up to 788 degrees C (1450 degrees F) and pneumatic argon or nitrogen pressure for removal of minor dents from copper pipe and tubing. Do not apply this procedure to pipe or tubing with cracks or dents that indicate probable failure of the pipe.

505-8.10.2.1 Cleanliness. Remove all foreign materials such as paint, heavy scale, grease, or other contaminants from the areas of pipe or tubing for at least 6 inches on each side of the repair area; it is not necessary to polish the pipe. The pipe or tubing shall be clean, dry, and free of solvents and flammable vapors.

505-8.10.2.2 Protection of Brazed Joints. Wrap all brazed joints and adjacent equipment within 3 feet of the repair area with wet cloths. Keep the cloth wet throughout the reshaping operation.

505-8.10.2.3 Temperature Control. Use temperature-indicating crayons (Tempstick) to ensure that heating is limited to 788 degrees C (1450 degrees F). When required, use other temperature-measuring devices such as optical pyrometers, contact thermometers, milli-volt meter, or other methods.

505-8.10.2.4 Pressure Control. Isolate the section of piping or tubing to be repaired from the rest of the system. Fill the piping with nitrogen or argon to a maximum pressure of 90 psi, but do not exceed the hydrostatic test pressure for the piping system. Monitor and regulate argon or nitrogen pressure throughout the operation.

NOTE

To protect against overpressurizing the area being repaired, provide a relief valve set at 95 psi.

WARNING

All personnel engaged in hot pipe reshaping operations, and all others who have to remain in the immediate area, shall wear safety goggles, safety glasses, or approved face shields during the heating operation for protection against a possible blowout. As far as practical, remove all personnel not engaged in the operation from the immediate area during the heating operation.

505-8.10.2.5 Heating. With pressure applied, slowly and evenly heat the repair area to not more than 788 degrees C (1450 degrees F) using an oxyacetylene brazing torch having a reducing flame. Provide adequate support to ensure that the installed pipe is not allowed to sag when softened by heating. If the pressure in the pipe being reshaped rises above the relief valve setting, discontinue heat and reduce pressure. Closely monitor the area being heated for signs of movement. Continue heating to the extent necessary to round out the dented area but not to exceed 788 degrees C (1450 degrees F). Light tapping with a smooth-faced mallet may be done to restore the surface to a smooth and continuous contour with the rest of the pipe.

505-8.10.2.6 Inspection Requirements. The Quality Assurance Inspection Department shall witness all reshaping operations. Unless otherwise specified, the repair will be inspected based on the acceptance criteria given in the following paragraphs.

505-8.10.2.6.1 Surface Condition. The reshaped pipe shall be free of cracks. Examine the pipe surface for pits, gouges, scratches, or tool marks. Randomly distributed, round-bottomed discontinuities are acceptable provided they do not exceed a depth of 0.005 inch or 5 percent of the nominal thickness, whichever is greater, and provided this depth does not reduce the wall thickness below its minimum requirement. Remove discontinuities exceeding this limit by fairing in, either by grinding or buffing, to a radius of three times the depth. The final wall thickness after defect removal shall meet the minimum thickness requirement.

505-8.10.2.6.2 Out-of-Roundness. Measure the reshaped pipe for out-of-roundness. It shall not exceed 8 percent when calculated as follows:

Out-of-Roundness (Percent) = OD Max - OD Min/OD Nominal x 100/1

Where OD Max = Maximum measured diameter at repair area; OD Min = Minimum measured diameter at repair area; and OD Nominal = Nominal pipe outer diameter as specified.

505-8.10.2.6.3 Flatness. Flatness shall meet the requirements of figure 505-8-1.

505-8.10.2.6.4 Wall Thickness. The wall thickness at the repair area of a reshaped pipe shall meet the minimum thickness requirements. Make measurements with a calibrated ultrasonic instrument according to NAVSEA T9074-AS-GIB-010/271, **Requirements for Nondestructive Testing Methods** .

505-8.10.2.6.5 Nondestructive Testing. Perform a liquid penetrant inspection on the area that was reshaped, plus at least 1 inch beyond the edges. Cracks are not acceptable. Examine and explore linear indications exceeding 1/16 inch in length to ensure that cracking is not present. If cracks are present, replace that section of pipe. Liquid penetrant testing shall be per NAVSEA T9074-AS-GIB-010/271.

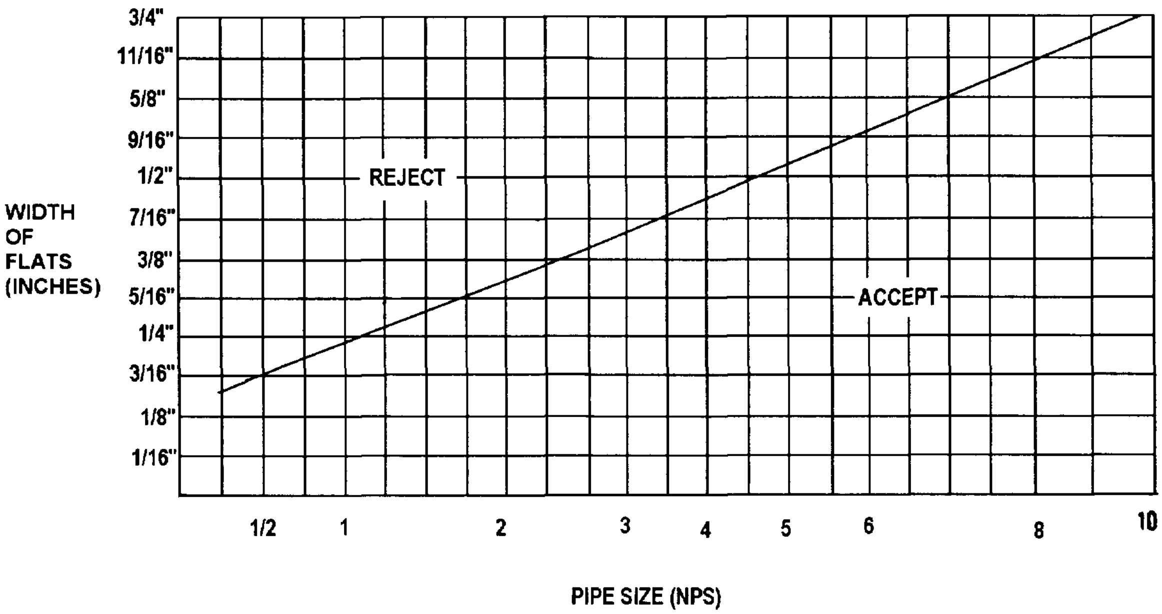
WARNING

When required to make a specified air test, personnel shall observe all safety measures.

505-8.10.2.7 Pressure Test. An air or gas test, subsequent to the hydrostatic test, except for air or gas systems at nominal operating pressure, shall not be performed due to the danger involved.

505-8.11 INSPECTION OF WELDED AND BRAZED REPAIRS

505-8.11.1 Where shipboard welding or brazing is required for repair or replacement of piping, inspect the joints according to the procedures given for the applicable class in NAVSEA S9074-AR-GIB-010/278 for welded joints or NAVSEA 0900-LP-001-7000, **Fabrication and Inspection of Brazed Piping Systems** , for brazed joints.



PIPE SIZE EQUIVALENTS (NPS OUTSIDE DIAMETER)

1/4" - 0.510	1" = 1.125	2" = 2.375	4" - 4.500
3/8" - 0.675	1 1/8" = 1.315	2 1/2" = 2.870	5" - 5.553
1/2" = 0.810	1 1/4" - 1.650	3" = 3.600	6" = 6.625
3/4" - 1.050	1 1/2" = 1.900	3 1/2" - 4.000	8" - 8.625
			10" = 10.750

Figure 505-8-1. Pipe Flatness Requirements

505-8.12 STEAM DRAIN SYSTEMS

505-8.12.1 Where steam traps have been replaced by orifices in the high-pressure drain system, the portion of the high-pressure drain system that is downstream of the stop-check valve, on the discharge side of the orifice assembly, on nonnuclear surface ships, is designated as a P-2 system (NAVSEA S9074-AR-GIB-010/278) instead of a P-1 system.

505-8.13 REPRESSURIZING PIPING SYSTEMS

505-8.13.1 SAFETY PRECAUTIONS. Comply with the following pressurizing safety precautions:

1. Be sure that all valves and equipment in or connected to the portion of the piping system to be pressurized are in the correct position or condition. Failure to do so may cause injury to personnel and damage to components. DO NOT admit steam or hot water into an open and occupied boiler, nor open circulating water valves upstream of an open condenser.
2. Because piping system documentation, such as drawings or Ship's Information Book, may not always be consistent or current with as-installed shipboard piping systems, take precautions to preclude inadvertent or

uncontrolled discharge of the system contents into the ship. This is especially true for any fuel piping system such as ship fuel (DFM), aviation fuel (JP-5) and gasoline, and in particular, for those portions of these systems which lead into or otherwise pass through normally inaccessible spaces such as voids, cofferdams, and uptakes.

3. As a minimum, reactivation of any fuel piping system or any portion thereof, following a break in system integrity shall not be initiated until and unless the completeness of the system or portion thereof, within any normally inaccessible area, has been visually inspected. This visual inspection shall ascertain that all piping runs are intact, all closures (including valves) are installed, and all joints (piping, valves, components, equipment, machinery) are made-up. Visual inspection shall be accomplished prior to any scheduled or planned hydrostatic and/or operational testing.
4. Crystallization and/or permanent deformation of main ballast tank hull stop valve seats and downstream Emergency Main Ballast Tank (EMBT) blow valve seats may result from rapid repressurization of the EMBT blow piping against closed main ballast tank hull stop valves. Repressurize piping as described in the next section.

505-8.13.2 CHECKS BEFORE PRESSURIZING. Ensure the following steps have been performed prior to repressurizing piping:

a. Properly clear all tagged out valves/components in accordance with NAVSEA S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL** .
b. To ensure proper operation, cycle all downstream valves, except those that would pressurize the system from another source, before pressurizing any portion of a piping system for operation or for test purposes.
c. Provide expansion joints with temporary restraints, if required, to resist the test pressure load or isolate them from the test pressure.
d. If temporary hoses are used either in test rigs or as jumpers within the system being tested, verify that the hose is adequate for the pressure test and fluid.
e. Eliminate air pockets before any system is pressurized for a hydrostatic test. The risk of large energy release due to a compressed gas volume applies, although to a lesser extent, if a system is not properly vented before a hydrostatic test.
f. Pressurize the system slowly. Ensure that the pressure can be relieved quickly upon detection of leakage or other abnormalities.

505-8.13.3 CHECK FOR LEAKS. During hydrostatic tests of flammable fluid systems or systems having a maximum system pressure in excess of 300 psi, raise test pressure in increments of approximately 25 percent from 0 to 100 percent of the final test pressure. At each increment, check for leaks before proceeding to the next higher pressure increment.

SECTION 9
VALVES

505-9.1 INTRODUCTION

WARNING

Ensure fasteners are of proper material. Black oxide coated brass can be mistaken for steel.

Valves are installed in piping systems to control the flow of fluids and perform the following basic functions:

1. Starting and stopping flow
2. Controlling flow rate
3. Diverting flow
4. Preventing backflow
5. Maintaining pressure
6. Relieving pressure.

505-9.2 VALVE TYPES

Many valve types have been developed to perform the above functions. A general discussion of the various valve types used in Navy piping systems is provided in the following paragraphs.

505-9.2.1 GATE VALVES. There are two types of gate valves: parallel and wedge. They are discussed below.

505-9.2.1.1 Parallel Gate. Parallel gate valves are slide valves with a parallel-faced closure member. The closure member may consist of single or twin discs with a spreading mechanism between the discs. Sealing occurs when the closure member contacts parallel sealing surfaces in the valve body. The seal is energized by upstream system pressure in single disc valves and by the spreading mechanism in twin disc valves. Twin disc valves do not rely on system pressure to energize the seal and are commonly referred to as bi-directional sealing valves. Twin disc valves seal more effectively in low-pressure applications.

505-9.2.1.2 Wedge Gate. Wedge gate valves differ from parallel gate valves in that the closure member is wedged-shaped instead of parallel. The purpose of the wedge is to produce a high seating load that enables the valves to seal effectively in low- and high-pressure applications.

505-9.2.2 GLOBE. Globe valves have a closure member that moves perpendicular to the valve seat. The closure member is commonly referred to as a disc, regardless of its shape. The flow area through the valve varies in direct proportion to the distance of the disc from the valve seat. As a result, globe valves are commonly used as flow regulators. In most applications, globe valves should be installed so that inlet flow will impinge on the bottom of the disc. There are some exceptions such as magazine sprinkler valves, where inlet flow impinges on the top of the disc.

505-9.2.3 PLUG. Plug valves are rotary valves in which a plug-shaped closure member is rotated through 90-degree increments to align with or block flow passages in the valve body. Tapered plugs are sealed by wedging them into a mating tapered valve body. Sealing can also be achieved by injecting a sealing compound, typically grease, into the cavity between the plug and valve body. High forces may be required to actuate tapered plug valves to overcome the friction between the plug and valve body. The friction is reduced in plug valves that employ actuators that lift the plug upward prior to actuation. The disadvantages to lift-type actuators are that fluid may be leaked when the plug is lifted and debris may become trapped between the plug and valve body sealing surfaces when the plug is reseated. To eliminate the need for a sealing compound and reduce friction, newer tapered plug valves employ a polytetrafluoroethylene (PTFE) liner located between the plug and valve body.

505-9.2.4 BALL. Ball valves are rotary valves in which a ball-shaped closure member is generally rotated through 90-degree increments to align with or block flow passages in the valve body. Most ball valves are equipped with circular elastomeric sealing surfaces that conform to the surface of the ball. Ball valves are particularly well-suited for use with fluids containing abrasives because the seals wipe the ball clean as the valve is closed. Ball valves provide a low-flow resistance when fully open.

505-9.2.5 BUTTERFLY. Butterfly valves are rotary valves in which a round disc-shaped closure member is rotated through a 90-degree increment to open or close the flow passage through the valve body. Butterfly valves provide a low-flow resistance when fully open and can be successfully used in some throttling applications.

505-9.2.6 CHECK. Check valves are automatic valves that open with forward flow and close against backward flow. Check valves are used to prevent return flow, maintain pump prime, enable proper operation of reciprocating pumps and compressors, and prevent standby pumps and compressors from being driven in reverse.

505-9.2.7 RELIEF. Relief valves are pressure-relieving devices that automatically relieve system pressure when it exceeds a preset limit, then close when system pressure is reduced below a preset limit.

505-9.2.8 REGULATING CONTROL. These are valves with a power-positioning actuator, either diaphragm or pilot-controlled, for moving the poppet to any position relative to valve port(s) in response to and in proportion to a signal.

505-9.2.9 BARSTOCK. The term barstock valve has been used traditionally by industry, the Naval Sea Systems Command (NAVSEA), and field activities to describe small, inexpensive globe or angle valves. Barstock is the material form commonly used to manufacture these valves. These valves are also made from forgings. To be suitable for shipboard use, these valves shall consist of a separate body, bonnet, stem, packing nut (packing retainer), stem seal, and handwheel or handle. They shall also have a positive stem blowoff protection feature. Packing rings, packing glands, and packing retainers do not provide positive blow off protection. The positive stem blow off feature is required to preclude removing the stem through the bonnet during valve opening and to prevent system pressure from ejecting the stem.

505-9.2.9.1 Union Bonnet. Another feature that the valve should have is a positive means of retaining the bonnet. Bonnets that are threaded directly to the body shall be avoided. If the stem becomes cross-threaded with the bonnet, the stem torque forces are transferred directly to the bonnet, with a potential of loosening the bonnet-to-body connection. Use of a union bonnet design in which a union nut holds the bonnet and body together is an acceptable method of dealing with this problem (see figure 505-9-1).

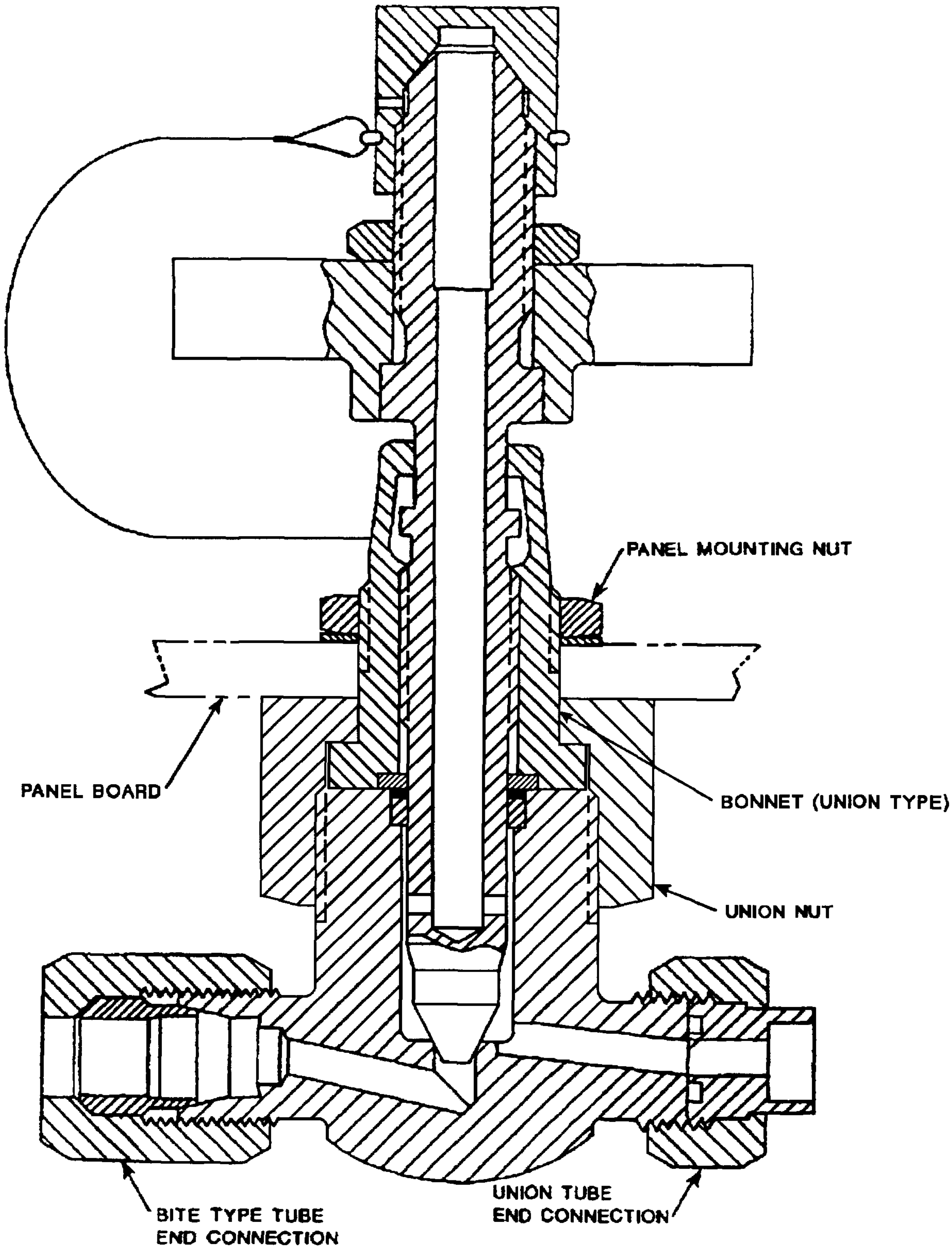


Figure 505-9-1. MIL-V-24578, Revision B, New Style Valve with Nonswaged Union Bonnet

505-9.2.9.2 Panel Nut. Valves of the union bonnet design which are normally provided with panel mounting nuts (that is, MIL-V-24578, Valves, Globe, Pressure Instrument, Stem Test Connection, Union End) instrumentation gauge valves, should have these nuts removed if the valve is not installed in a panel board. In nonpanel board installations, the panel nut may be accidently tightened against the union nut, which locks the bonnet, union nut, and panel nut together as an assembly, resulting in problems identical to that of the directly threaded bonnet-to-body valves (see paragraph 505-9.2.9.1).

505-9.3 REPLACEMENT VALVES

505-9.3.1 GENERAL. Consult ship drawings, MIL-STD-777 **(Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships)** , or MIL-STD-438 **(Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarine Service)** to identify replacement valve requirements. (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.) Root valves on branch lines for vent, drain, sampling, and instrumentation shall conform to the same requirements as the rest of the system. In carbon steel systems, where the operating pressure does not exceed 200 lb/in.^{2} , the use of small, commercial union bonnet valves, as described herein, is acceptable for root valves. In all cases, the end connections of these carbon steel valves shall be socket-welded. For new installations, most vent, drain, and sampling applications and root connections up to 200 lb/in.^{2} operating pressure can be served by a 1/4-inch size, carbon steel, socket-welded valve according to MIL-V-24586 **(Valve, Needle, Size 1/4-Inch and 1/2-Inch, Union Bonnet Construction)** and meeting the requirements stated herein. In nonferrous systems up to 400 lb/in.^{2} , the valves shall be according to NAVSHIPS DWG 803-4384536. For valves in instrumentation piping downstream of the root valve, see NAVSEA DWG 803-1385850.

505-9.3.2 EXISTING BARSTOCK VALVES. Where currently installed, barstock valves meeting all of the requirements herein, except the union or bolted bonnet construction, may be retained subject to the following limitations:

1. As instrument cutout valves downstream of a root valve.
2. As vent, drain, and sampling valves, except for flammable fluid systems, where they are permitted only within areas enclosed by strainer shielding.

505-9.3.3 RESTRAINING DEVICES. In the foregoing applications, fit the valves with a restraining device or keeper to prevent the bonnet from backing out of the body. Any device that meets this requirement is permitted except one that requires machining of the valve. Existing installations where the bonnet is pinned to the body are acceptable.

505-9.4 INSTALLATION

505-9.4.1 GENERAL. Install valves so that they are accessible for repair or replacement. The best installed position of a valve is with the stem pointing straight up. If the stem points down, scale and other foreign matter in the line may collect in the bonnet. Such debris may interfere with valve operation by cutting, and eventually destroying, stem threads. Gate valves in steam systems may accumulate trapped condensate in the valve bonnet which when heated up will expand and can cause valve rupture (see paragraph 505-9.15.9.1). Fit valves with drains when required in steam service.

505-9.4.2 COLD TEMPERATURES. In liquid lines subject to freezing temperatures, a stem down position for valves is undesirable because liquid trapped in the bonnet may freeze and cause the valve to rupture. Even when installed upright, valves in such lines shall have drain plugs in the body as a precaution against freezing.

505-9.4.3 GLOBE VALVES. Consult ship drawings or equipment manuals for globe valve installation requirements. Globe valves are generally installed with the system pressure or vacuum under the disc, so that in the closed position the pressure or vacuum loads are not exerted on the bonnet joint or stem packing. One known exception to this convention is magazine sprinkler valves. They are to be installed so that the system pressure is applied to the top of the disc.

505-9.4.4 CHECK VALVES. Install check valves so the disc (or ball) will open with the desired direction of flow. To ensure disc closure when backflow occurs, the position of check valves in the line shall permit closure of valve disc by gravity. In some cases, globe or angle stop valves have been modified into stop-check valves, without marking the valves with some external identification regarding the modification. In many cases, these valves have been installed in the wrong direction with consequent damage or malfunction. Wherever a stop valve has been modified to a stop-check valve, a flow arrow should be stamped or engraved on the valve to indicate direction of flow. Insert a plate or disc under the handwheel nut, marked: STOP-CHECK VALVE - CAUTION: INSTALL IN CORRECT DIRECTION WITH STEM IN UPRIGHT POSITION.

505-9.5 THROTTLING

505-9.5.1 GENERAL. Globe, angle, and needle (micrometer) valves are preferred in throttling application. Gate, rotary plug, and ball valves are not commonly used. Butterfly valves have fair throttling characteristics, but severe throttling is limited to the metal-to-metal seated type (see paragraph 505-9.13).

505-9.6 LEAKAGE

505-9.6.1 SEAT LEAKAGE (INTERNAL). Internal valve leakage occurs at valve seats or seals. All valve types are not expected to be leaktight, even when they are new. However, the leakage rate can become unacceptable because of the problems discussed in paragraph 505-9.6.1 through 505-9.6.1.9. Repair procedures to achieve the required seat tightness are discussed in paragraph 505-9.10. Seat tightness acceptance criteria are provided in paragraph 505-11.3.6.

505-9.6.1.1 Foreign Substances. Foreign substances, such as scale, dirt, waste, or heavy grease may become embedded in the seat and prevent formation of a tight seal. If the obstructing material cannot be flushed through, disassemble and clean out the valve.

505-9.6.1.2 Scoring. Seat or disc scoring is caused by closing the valve on scale or dirt or by erosion. Lapping may restore a tight seal depending on the degree of scoring.

505-9.6.1.3 Cocked Disc. Discs maybe cocked if the feather guides fit too tightly or if the spindle guide or valve stem is bent.

505-9.6.1.4 Damaged Seat or Disc. The valve body or disc may be too weak, permitting distortion of the valve seat or disc under pressure or closing force.

505-9.6.1.5 Improper Disc-to-Seat Contact. The discs and seat may not have been machined properly, preventing proper disc-to-seat contact. This condition may be corrected by lapping of the mating parts.

505-9.6.1.6 Extraneous Internal Leakage. Leakage paths may occur between inserted seats or threaded seat rings and the valve body.

505-9.6.1.7 Casting Defects. Casting defects may be present in the valve disc or body. The defects may be porous and result in internal or external valve leakage or both.

505-9.6.1.8 Seat Warping. In brazed valves, seat warping may result from applying excessive heat to the valve body during brazing.

505-9.6.1.9 Loose Disc. A loose valve disc can cause improper seating or leakage between the stem and disc. Tightening of the mechanism that connects the disc to the valve stem may eliminate the leak.

505-9.6.1.10 Missing Discs. Some failures of butterfly discs of the incorrect material have resulted in the valve disc becoming detached because of corrosion and being carried into the piping.

505-9.6.1.11 Damaged/Worn Elastomeric Seals. Elastomeric seals in butterfly, ball, globe, and plug valves can be damaged by debris entrained in the system fluid or can become brittle or worn from use. Replace seals as required.

505-9.6.2 STUFFING BOX LEAKAGE (EXTERNAL). Stuffing box leaks may be remedied by tightening gland nuts or by replacing all the packing in the valve. Persistent stuffing box leaks are usually caused by a bent or scored valve stem. Considerable trouble with stuffing box leaks may be avoided if valves are installed with the valve stem pointing up. Before altering the position of a valve consider convenience of operation and availability of space for removing the bonnet, stem, and disc.

NOTE

Overtightening of gland nuts can lead to packing extrusion or stem binding.

505-9.6.2.1 Bolted-Bonnet Gasket Replacement. High-pressure steam valves may have been furnished originally with a spiral-wound metallic gasket or serrated metal, flat, corrugated soft iron, or steel gaskets. Use spiral-wound gaskets to replace bonnet gaskets in those instances where the original gasket type has proven unsatisfactory or troublesome and where gasket substitution can be done without significant machining or other valve modification.

505-9.6.2.1.1 Valve Packing. Two types of valve packing are in use, asbestos and graphitic. In general, the graphitic packing is intended to supersede asbestos packing. A graphitic packing set generally consists of three graphitic seal rings sandwiched between two graphitic yarn anti-extrusion rings, for stuffing boxes with depth greater than the 5 ring stack height, split carbon bushings or stainless steel spool pieces are installed. The graphitic yarn rings preclude extrusion of the graphitic seal rings out of the stuffing box. The graphitic seal rings are available as preformed rings or as corrugated ribbon. Preformed graphitic seal rings are preferred. However, the use of corrugated ribbon packing in all steam, feedwater and condensate valves in steam propulsion plants is authorized on all ships. For detailed description and installation of valve packing, refer to NSTM Chapter 078, Volume 2,

Gasket and Packing For a detailed description of graphitic packing, refer toMIL-P-24503, **Packing, Material, Graphitic, Corrugated Ribbon or Textured Tape and Preformed Ring** , and MIL-P-24583, **Packing Material, Graphitic or Carbon Braided Yarn** . For installation in standard navy valves, refer to 0948-LP-012-5000, **Standard Navy Valves** . For installation in other valves, refer to S9253-AD-MMM-010, Volume I, **Valves, Traps, and Orifices (Nonnuclear) User Guide and General Information** .

505-9.6.2.2 Pressure-Seal Bonnet Seal Ring Replacement. When reassembling pressure-seal bonnets, install new pressure seal-rings to ensure a tight seal is obtained. When installing valves that have pressure-seal bonnets, verify that the bonnet joint is tight before subjecting the valve to line pressure. Check the joint for leaks immediately after the valve has been subjected to line pressure and again after 2 or 3 days of operation. This minimizes the potential for leakage past the seal-ring.

505-9.6.3 EXTERNAL LEAKS IN HIGH-PRESSURE VALVES. Small leaks in high-pressure valves can result in a significant loss of system fluid. Table 505-9-1 provides leakage losses expected through various size holes. Unless immediately repaired, the leak path may grow rapidly due to the erosive effect of high-velocity fluid passing through the opening. In addition to the loss of system fluid, high-pressure leaks pose a personnel safety hazard. The noise generated can affect communication among crew members and may cause permanent hearing impairment. Also, steam leaks can cause a dramatic increase in space temperature.

Table 505-9-1. AIR, STEAM, OR WATER LEAKAGE LOSS

Diameter Opening Size	Loss per Month at 100 lb/in.^{2}		
	Air (ft^3)	**Steam (pound)**	**Water (gallon)**
1/4	4,449,600	203,000	307,700
1/8	1,114,560	50,500	76,900
1/16	278,640	12,750	19,200
1/32	69,552	3,175	4,800

505-9.7 VALVE STEM STICKING.

Valve stem sticking can be caused by the problems described in the following paragraphs.

505-9.7.1 TIGHT PACKING. The stuffing box may be packed too tightly. Reduce packing pressure by loosening the gland nuts.

505-9.7.2 GLAND COCKED. The stuffing box gland may be cocked due to uneven tightening of the gland nuts. Correct the position of the nuts. Refer to the applicable valve technical manual for proper adjustment of packing gland nuts.

505-9.7.3 FOULED VALVE STEM OR GLAND. Remove paint, rust, and extruded packing from the stem or gland.

505-9.7.4 DAMAGED VALVE STEM. Straighten or replace the stem if bent, nicked, galled, or otherwise damaged.

505-9.8 INOPERABLE VALVES

505-9.8.1 GENERAL. There are several causes of inoperable valves including debris-jamming operating mechanisms, high seat loads, and damaged valve components. The actual cause should be identified and repaired quickly to ensure proper system operation, especially during emergency conditions.

505-9.8.2 REMOTELY-OPERATED VALVES. Cycle remotely-operated valves locally by manual means, where possible, to assess the amount of handwheel force required to operate them. For power operated valves, there may be a clutch which disengages power while manual operation is accomplished. Generally, if this feature is present, the actuator power will be automatically re-established. For remotely operated valves using manual remote operating gear, it is necessary to disconnect the mechanical gear. If disconnection of remote operating gear is required, be sure to reconnect gear and align it properly with valve position in accordance with applicable technical documents. If a valve cycles smoothly upon applying a reasonable amount of handwheel force, inspect the remote actuating system for potential problems. To troubleshoot the remote actuating system, consult applicable technical documents for trouble shooting procedures (see paragraph 505-9.14.1). Potential problems which may impact remote actuating system include, but are not limited to, the following:

1. Damage to moving parts.
2. Broken or missing connecting pins or keys.
3. Improperly supported or misaligned remote actuating system components.
4. Excessive side loading of rigid parts.
5. Presence of corrosion products or lack of proper lubrication.
6. Incorrectly adjusted torque or travel limit settings.

WARNING

During normal valve operation, the use of a wrench to open or close a valve is prohibited. However, if a valve is jammed, a wrench may be used to operate it, provided the torque applied does not exceed that permitted for the applicable handwheel diameter. Excessive operating torque may cause the disc and stem to separate or damage the valve stem threads. A jammed-shut wedged gate valve installed in a high-pressure steam system may indicate body neck overpressurization (see paragraph 505-9.15.9).

505-9.8.3 MANUALLY-OPERATED VALVES. Apply the maximum permissible handwheel force to inoperable manually-actuated valves. This may be easier to do by using a handwheel spider adapter, which contacts the handwheel spokes, with a torque wrench applied to the adapter, or by using a handwheel wrench. If this action fails to operate the valve, consult paragraph 505-9.8.3.1 through 505-9.8.3.3.

505-9.8.3.1 Differential Pressure. High operating forces can be caused by high differential pressures applied across closed valves. This is especially true for large diameter gate valves. The differential pressure causes high contact forces between the disc and body seats that resist movement. This force can be reduced by equalizing the pressure across the valve. Bypass lines may be installed on the valve for this purpose. Pressure equalization will also reduce the force required to operate globe and ball valves.

505-9.8.3.2 Stem/Bonnet Threads. Inspect the stem and bonnet/yoke threads for damage. Damaged threads may cause thread seizure. Verify that the threads in the bonnet/yoke are not stripped. This condition exists when the valve stem rotates, but the valve does not cycle. When the bonnet/yoke valve stem threads are located in a bushing, verify that the bushing is not rotating in the bonnet/yoke as the valve stem rotates. Repair/replace parts as required.

505-9.8.3.3 Valve Body Distortion. Piping loads can cause valve body distortion. This distortion can cause valve stem sticking and disc jamming. Frequently, the bonnet must be loosened from the valve body to relieve any misalignment and free the valve. Do not loosen bonnet fasteners when the valve is pressurized.

505-9.9 MAINTENANCE

505-9.9.1 GENERAL. Valve maintenance shall be per Maintenance Requirement Cards (MRCs) where a Planned Maintenance System (PMS) has been implemented. Maintenance procedures discussed in this section supplement those provided in PMS, valve drawings, Technical Repair Standards (TRSs), and Submarine Maintenance Standards.

505-9.9.2 PERIODIC INSPECTION. Make periodic inspections of stems that previously have shown signs of corrosion, so replacement can be made before failure occurs. To prevent failure by corrosion, split pins in valve discs in water lines shall be of nickel-copper alloy instead of iron or steel.

505-9.10 SEAT REPAIR

505-9.10.1 GENERAL. The presence of hairline cracks in valve seating surfaces does not require seat repair. Seats require repair when leakage occurs through cracks in the valve seat at system operating pressure. As a general guideline, seats having hairline cracks that are not leaking will usually be smooth to the touch. Conversely, hairline cracks causing leakage can usually be felt. Inspect seat and disk for uneven or excessive wear, pits, cracks, steam cuts, erosion, or improper fit of disk on seat. Use the spotting-in method described in S9253-AD-MMM-010, **Valves, Traps, and Orifices Nonnuclear User's Guide and General Information** , to determine if disk and seat are mating properly. Prior to initiating seat repairs, obtain seat dimensional and material requirements from applicable drawings or manuals.

505-9.10.2 DAMAGE CATEGORIES. The method and extent of effort required to repair valve seats depends on the severity of the damage. Damage is separated into two categories. Minor damage such as nicks, scratches, or minor pitting can be removed by grinding and/or lapping. Major damage that cannot be removed by lapping must be machined to a smooth surface, built up by welding, and machined to original specifications.

NOTE

Where damage is severe, it may be more economical to replace the entire valve.

505-9.10.3 VALVE RESEATING MACHINES. Use valve reseating machines to repair seats in-place when possible. These machines are available for most sizes and varieties of globe and gate valves. Use of these machines is generally quicker, safer, and as effective as removing the seat from the valve body for repair. Operating instructions for these machines are contained in related technical manuals.

CAUTION

Be careful not to generate excessive heat when repairing seating surfaces with valve reseating machines. High temperatures can cause dimensional problems, changes in material properties, and cracking during cooling.

505-9.10.4 GRINDING. Grinding is performed to ensure that there is continuous contact between the disk and seat. Grinding compound is applied to the disk seating surface and rotated back and forth against the seat. The disk and seat are occasionally separated to introduce additional grinding compound and permit cooling. Verify proper contact between seat and disk by spotting-in (blueing either the disk or seat, then bringing the disk into contact with the seat). The blueing ring should be an unbroken line of contact 100 percent around the mating seat or disk, and of uniform width.

505-9.10.5 LAPPING. Lapping tools are used to remove defects in the seating surfaces of the valve seat. The use of abrasive cloth attached to a lapping tool is preferable to the use of lapping compound. Critical lapping tool surfaces will wear away more rapidly when compound is used. Remove only the minimum amount of material from the surface to remove the defect. Excessive material removal may cause an improper disk-to-seat contact on gate and globe valves and improper alignment of ports on plug valves. Verify proper contact between seat and disk by spotting-in (blueing either the disk or seat, then bringing the disk into contact with the seat). The blueing ring should be an unbroken line of contact 100 percent around the mating seat or disk, and of uniform width.

NOTE

EXISTING PARAGRAPH 505-9.11 THROUGH 505-9.11.6.5 HAVE BEEN RELOCATED TO NEW SECTION 11 ON TESTING.

505-9.11 LUBRICATED PLUG VALVES

NOTE

For plug valves in seawage and seawater systems which are in accordance with MIL-V-24509, if excessive and repeated seizing of the valve occurs, consider upgrading valve to a new revision of MIL-V-24509. Newer revision valves do NOT require lubrication, thus decreasing maintenance burden. Such replacement valves have the same end-to-end dimensions, allowing easy one-for-one replacement without piping system modifications. If this occurs, ensure parts support APL/AEL is modified to suit.

505-9.11.1 ADDING LUBRICANT/SEALING COMPOUND. To add lubricant/sealing compound to lubricated plug valves, remove the lubricant setscrew from the stem, insert a stick of the recommended service lubricant, and force lubricant into the cavity between the plug and valve body by means of the lubricant screw.

505-9.11.1.1 The number of sticks of lubricant required depends on the valve size. For plug valves that do not have packing glands, insert sticks around the neck of the plug until the service lubricant starts escaping to the atmosphere. For packed plug valves, insert sticks until considerable back-pressure is felt on the lubricant screw. This indicates that the valve cavity is fully packed with lubricant.

505-9.11.1.2 When turning the lubricant screw down, the plug valve should be fully open or fully closed. While introducing the lubricant, rotate the plug to distribute the lubricant over the bearing surfaces. A check valve is located in the lubricant passage directly under the lubricant screws to prevent the lubricant in the valve from being extruded from the chamber when the lubricant screw is removed. The check valve also permits the valve to be recharged while under pressure.

505-9.11.1.3 To ensure leak tightness, maximum life, and ease of operation, add lubricant/sealing compound to the valves at regular intervals as required by the applicable MRC.

505-9.12 ROTARY-LIFT PLUG VALVES

505-9.12.1 PLUG VALVE COATING. Rotary-lift plug valves used in aviation gasoline and similar hydrocarbon services are fitted with rubber-coated plugs. The rubber coating can not have a hardness greater than 75 Shore A durometer for the valves to operate properly. Therefore, there is a need for periodic inspection and checking of the durometer of plugs carried as onboard spares. Inspections can be conducted at naval shipyards and repair activities where testing equipment is available.

505-9.12.2 DUROMETER TESTING. When Shore A durometer testing, take five to ten readings per plug on the finished seating surfaces in different locations and average the results.

505-9.12.3 REPLACEMENT VALVES. Reduction in the use of aviation gasoline has so reduced the requirement for rotary-plug valves that replacement valves are no longer available from commercial sources. Where recoating cannot be accomplished by a shipyard or repair activity, replace plug valves with butterfly valves according to MIL-V-24624, Valves, Butterfly, Wafer and Lug Style, Shipboard Service.

505-9.13 BUTTERFLY VALVES

505-9.13.1 GENERAL. The fleet is going through a transition period with respect to butterfly valves. The old style rubber-lined valves per MIL-V-22133 are not being used on new construction ships. High-performance butterfly valves (HPBV) per MIL-V-24624 have been used on new construction ships starting in 1983 and should be used to replace troublesome rubber-lined valves in older ships. The HPBV has several improvements over the rubber-lined valves such as: positive internal stops to prevent disk from rotating 180 degrees out of position, positive features to prevent stem ejections, and firesafe features.

505-9.13.2 APPLICATIONS. Butterfly valves are permitted only in applications identified in MIL-STD-777 **(Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships)** , or MIL-STD-438 **(Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarine Service)** . (For SEAWOLF Class, use Project Peculiar Document 802-6335710, and for NSSN Class, use Project Peculiar Document 802-6337450.)

505-9.13.3 THROTTLING. Where authorized, metal-to-metal seated butterfly valves may be used in severe throttling service. Throttling is considered severe if:

1. Valves are set at an opening less than 20 degrees.

2. Pressure drop across the valve exceeds 50 psi.

505-9.13.4 ISOLATION. Do not use old style rubber-lined or metal-seated butterfly valves, in accordance with MIL-V-22133, as isolation pressure barriers for maintenance of equipment or valves. MIL-V-24624 HPBVs may be used as isolation pressure barriers.

505-9.13.5 INSPECTION FOR PROPER ASSEMBLY. Old style valves manufactured by Norris Seal to MIL-V-22133 are unique in that when the actuator is removed, the disc can be inadvertently rotated 180 degrees out of position. This can unseat the disc causing leakage.

WARNING

Some old style valves have two-piece stems that are not mechanically attached to the disc. Therefore, if the stem thrust plate or actuator is removed, the stem can be ejected by internal system pressure.

505-9.14 REMOTE OPERATING SYSTEMS

505-9.14.1 GENERAL. Remote operating gear is installed to permit valve operation from distant locations. It may consist of mechanical, hydraulic, pneumatic, or electric-powered devices. Mechanical remote control systems shall be in accordance with S9505-AG-MMM-010, **Rigid Rod Valve Remote Control Systems** ; 0948-LP-022-7010, **Valve Remote Control Systems** (Rotary Flexible Shafting); S6435-QJ-MMI-010, **Dual Linear Remote Mechanical Valve Actuator** ; S6435-SM-MMM-010, **Rotary Flexible Shafting Mechanical Actuator System** ; S6438-AA-DDT-010, **Single Linear Flexible Shafting Valve Actuator** ; or other upon NAVSEA approval.

505-9.14.2 MAINTENANCE. The consequences of a major failure in valve remote control systems makes proper maintenance and operation of valves and associated operating gear essential. For example, during a flooding casualty, the remote sea valve operator may fail to function properly, causing machinery spaces to be flooded.

505-9.14.2.1 Before startup or shutdown of a system, operate all valves both manually and by installed power operators. During the functional tests, observe the operation of all components, controls, and indicating devices to ascertain that they are in good working order. Perform needed repairs at the earliest opportunity.

505-9.14.2.2 Use of air to operate or test hydraulic motors or cylinders of hydraulic valves is prohibited.

WARNING

Prior to cleaning or lubricating components of a powered valve actuating system, ensure that the actuator's power (electrical, hydraulic, or pneumatic) is secured.

505-9.14.2.3 Visually inspect valves and their actuators periodically to ensure that external exposed moving parts are clean. Pay particular attention to the cleanliness of any tripping devices involved in valve operation. Some power actuators employ mechanical remote control components like rigid rods and universal joints. Care should be taken to ensure these components are clean and properly lubricated.

505-9.14.3 SOLENOID VALVES. Solenoid valves should be periodically operated to ensure reliable operation. This is particularly true when valves are located in areas that are difficult to keep clean.

505-9.14.3.1 Before placing any system containing solenoid valves into operation, cycle the valves. Also cycle during operation at least once a month.

505-9.14.4 MAIN STEAM PIPING AIR MOTOR-OPERATED VALVES ON SURFACE SHIPS. The following criteria shall be used to assess the closure time of air motor-operated valves installed in main steam systems:

1. Closure time specified in the subject valve technical manual
2. Fastest closure time specified in operational documents such as Engineering Operational Sequencing System (EOSS) or the steam plant manual for specific casualty control evolutions
3. When closure time or rates are not specified, use the following criterion: the operator shall close a gate valve at a rate of not less than 12 in./min and a globe valve at a rate not less than 4 in./min over the full travel of the valve.

505-9.14.5 TOGGLE-OPERATED VALVES. Toggle-operating mechanisms similar to that shown in figure 505-9-2 are installed on some valves. This mechanism generates high closing and opening forces from small handwheel forces. Some mechanisms may be motor-operated.

505-9.14.5.1 Adjust toggle-operating gear for proper operation as follows:

a. Close valve.
b. Adjust the stop if the toggle operating mechanism engages, stops, or is at end of travel before the valve is closed. If this is not possible, adjust the position of crosshead on valve stem so neither the toggle mechanism nor the stop bottoms.
c. Ensure that the angle between the stem and toggle link is approximately as shown in the manufacturer's instruction manual; adjust position of the crosshead on stem, if necessary.
d. Recheck stop as described in step b.

505-9.14.5.2 If the toggle mechanism is adjusted while the valve is cold, open and close the valve at approximately every 100 degrees F of temperature rise during warm-up. This procedure will ensure that the valve is not frozen shut. Upon completion of warm-up, readjust stop as in step b, paragraph 505-9.14.5.1. Make a final check of the toggle mechanism after it and the valve body have been uniformly heated to approximate operating temperatures, upstream and downstream.

505-9.15 STEAM SYSTEM PRESSURE-SEAL BONNET GATE VALVES

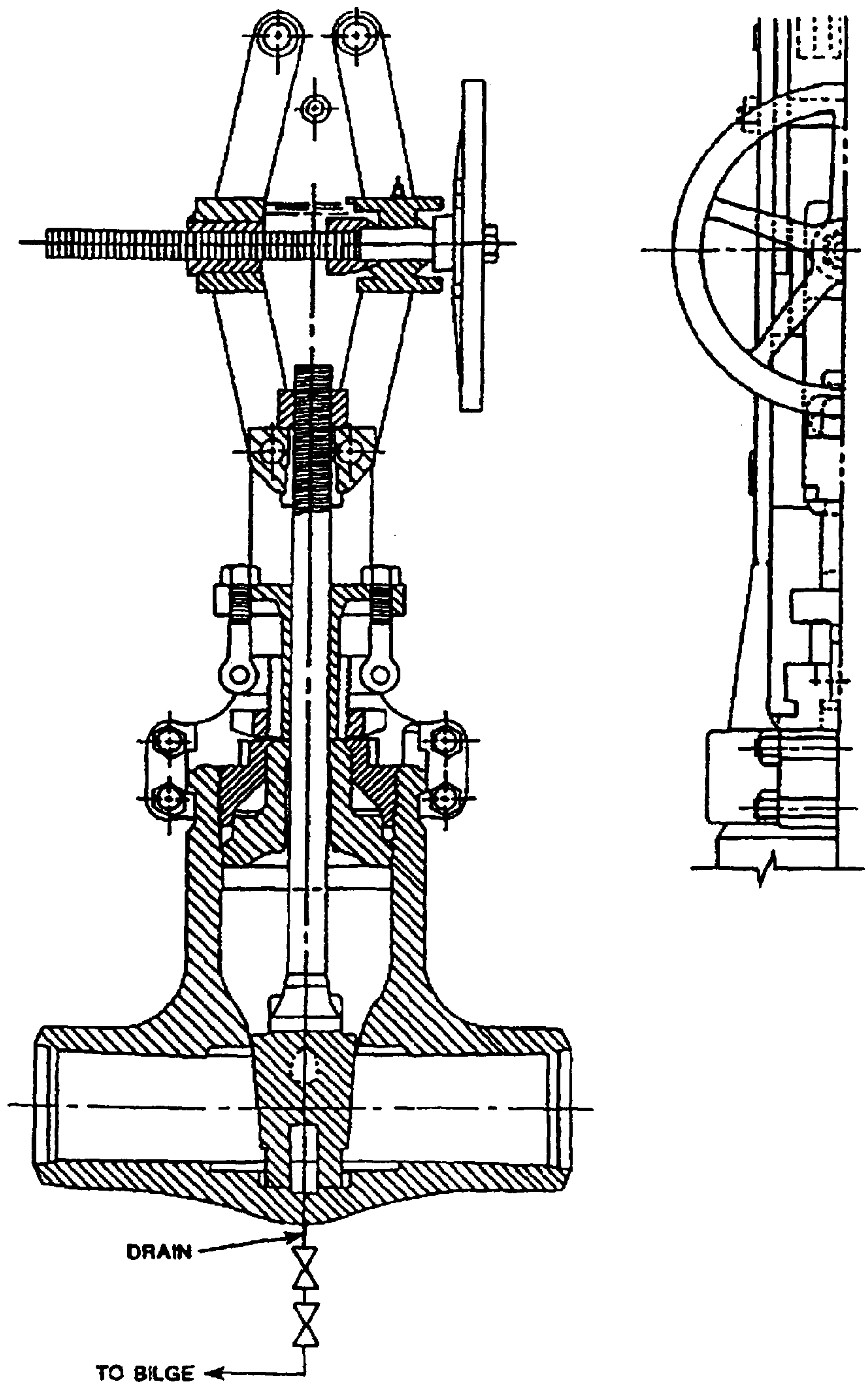


Figure 505-9-2. Toggle-Operating Mechanism

505-9.15.1 600 PSI AND HIGHER. Most gate valves installed in recent years in high-pressure steam systems (600 lb/in.^{2} and above) have been of pressure-seal bonnet design. Considerable weight and space savings have been achieved by eliminating the large bonnet flanges previously used on bolted-bonnet type valves.

505-9.15.2 SOLID WEDGE VALVES. Pressure seal bonnet gate valves in sizes 2-1/2 inches and smaller generally have solid wedges, while sizes 3 inches and larger are provided with wedges of a flexible design (there may be some variation among manufacturers).

505-9.15.3 FLEXIBLE WEDGE VALVES. Flexible wedge designs prevent binding when the valve is closed. In high-pressure and high-temperature steam systems, pipe line expansion produces stresses and strains at valve end connections that slightly distort the valve bodies. If the valve wedge is solid, the body seat load applied to the wedge may cause the valve to be jammed shut. This problem is overcome with flexible wedges, which are best described as two circular plates attached by an integral hub. The wedges flex as the valve seats press against them, thereby minimizing the jamming effect. Because of this desirable characteristic, the Navy, as well as industry, uses flexible wedge valves in all cases where piping system expansion is significant.

505-9.15.4 PRESSURE-SEAL BONNET DESIGN. Use of internal fluid pressure to seal the bonnet joint is the basic principle of the pressure-seal design. The pressure-seal design has proven efficient when used in high-pressure, high-temperature applications.

505-9.15.4.1 A typical bonnet pressure-seal is illustrated in figure 505-9-3. The bonnet fits into the body followed by the wedge-shaped pressure-seal ring. A retaining ring in the form of a threaded ring, split ring, or segmented ring is used to back up the seal ring. A bonnet plate or ring is used with studs or caps crews to assemble the valves.

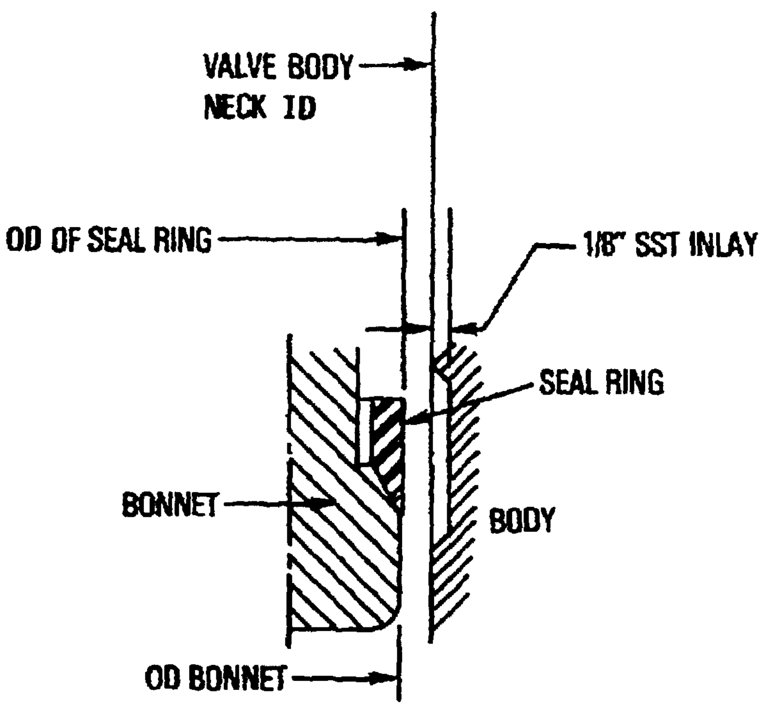


Figure 505-9-3. Pressure-Seal Arrangement

505-9.15.4.2 Internal fluid pressure acting on the underside of the bonnet forces it against the pressure-seal ring, which wedges the ring between the bonnet and valve body. High sealing forces are generated because the bonnet pressure area is significantly greater than the seal ring contact area. Therefore, leakage of a properly maintained pressure-seal joint is extremely rare.

505-9.15.5 VALVE BONNET TIGHTENING AFTER INSTALLATION. The valve should not leak externally during or after the initial warm-up. However, all stressed metals tend to creep under prolonged exposure to temperatures. Therefore, verify the tightness of the bonnet assembly approximately 24 hours after warm-up, and again 1 month after the valve has been in service at full working pressure and temperature.

505-9.15.6 PRESSURE SEAL-RING (GASKET) REPLACEMENT. Whenever pressure-seal bonnet valves are disassembled, install a new, low-carbon steel, silver-plated pressure-seal ring. When lapping or refinishing of the inlay in the valve body is necessary to eliminate cuts or scratches, the inside diameter of the inlay may increase to a point where the use of a standard size pressure-seal ring is not possible. In such cases, install an oversized seal ring per NAVSEA DWG 803-5001021.

505-9.15.6.1 Select seal ring size based on the average measurement of the inside diameter (ID) of the valve body neck in the area of the inlay. The outside diameter (OD) of the seal ring shall be the largest size listed in NAVSEA DWG 803-5001021 for the appropriate valve, but shall permit a minimum diametrical clearance of 0.002 inch between the inlay and the seal ring. If the valve body neck ID becomes more than 0.012 inch larger than the OD of an oversize number 2 seal ring, replace the inlay and restore the OD of the bonnet as necessary. Seal rings not listed in NAVSEA DWG 803-5001021 may be manufactured using the dimensional details in this paragraph. For the machining of the replaced inlay, define the desired valve body neck ID as the OD of the standard seal ring plus 0.002 inch. In case of doubt, repair activities shall contact NAVSEA.

505-9.15.6.2 The activity reassembling the valve is responsible for attaching a metal identification tag on the valve indicating the size seal ring (either standard, oversize one, or oversize two) that has been installed, name of the installing activity, and date of installation. Do not accept a repaired pressure-seal ring valve unless it is equipped with this metal identification tag. If operational commitments dictate acceptance of an untagged valve, use a message and Deficiency Material Report (DMR) to document the acceptance.

505-9.15.7 INSPECTION FOR PROPER ASSEMBLY. Flexible wedge pressure seal gate valves manufactured by Walworth Company and Crane Company use the same basic pressure-seal bonnet construction. In sizes 3-1/2 through 5 inches, the yoke acts as a retaining ring and is threaded into the body to retain the bonnet and pressure-seal ring. In sizes 6 inches and larger, a separate threaded retaining ring is used for this purpose. This retaining ring has a drive lug cast as an integral part of the top of the ring. For sizes 3-1/2 through 5 inches, expose no more than one full male thread on the yoke above the top of the body. For sizes 6 inches and larger, expose no more than one full male thread on the retaining ring (not counting the drive lugs) above the top of the body. Where more than one full thread is exposed, disassemble the valve, check, and reassemble at the first availability.

NOTE

A full thread is defined as one 360-degree rotation of a full thread form.

505-9.15.7.1 Valves manufactured by Anchor-Darling Valve Company use a split ring to contain the pressure-seal ring and valve bonnet. In sizes 4 inches and larger, a bonnet retaining ring fits inside the top of the body over the split ring, with bolts used to pull the bonnet up against the seal ring. The top of this bonnet retaining ring shall be flush with the top of the body within 1/16 inch. In sizes 2-1/2, 3, and 3-1/2 inches, the bonnet retaining ring is threaded over the outside of the bonnet and fits into the body over the split ring. Cap screws are fitted in this retaining ring to pull up the bonnet. Check these cap screws for tightness. If loose, tighten them evenly.

505-9.15.7.2 Valves manufactured by Velan Engineering Company use a segmented thrust ring similar to the Anchor-Darling ValveCompany split ring. The thrust ring is wedged into place by a thrust ring expander. The load transmitted by the thrust ring expander is secured with a threaded or bolted adjustable bonnet clamp. Valve sizes 3 and 4 inches require exposure of 2 to 2-1/2 male threads on the bonnet above the threaded bonnet clamp. Check valves 6 inches and larger by measuring the distance from the bottom of the clamp, to which the gland bolts are attached, to the top of the bolted clamp that fits over the OD of the bonnet. On a 6-inch valve this dimension shall be 2-1/4 inches plus or minus 1/8 inch; on an 8-inch valve, 3-3/8 inches plus or minus 1/8 inch.

505-9.15.8 DISASSEMBLY AND REASSEMBLY. See technical manual S9253-AD-MMM-010, **Valves, Traps and Orifices (Non-Nuclear); Vol 1, User's Guide and General Information; Maintenance Manual** , volumes 1 through 14, for detailed disassembly and reassembly instructions for 1200-psi and 600-psi propulsion steam plant valves. NAVSEA 0948-LP-012-5000, **Standard Navy Valves** , also provides instructions for the disassembly, repair and reassembly of steam plant valves.

505-9.15.9 PROTECTION AGAINST BODY NECK OVERPRESSURIZATION IN GATE VALVES. It is characteristic of closed flexible wedge gate valves for water to become trapped in the body neck as a result of hydrostatic testing. The water will remain trapped until the valve is opened or the water is removed through a body neck drain. Water can also enter a low point drain, such as the body neck drain for inverted valves and for upright valves; a drain located at the bottom of the valve between the disc seats; and when the valve is in the closed position and a differential pressure is applied across the wedge. The pressure can cause the upstream side of the wedge to move away from the body seat, permitting water to enter the body neck. As the differential pressure decreases, the upstream side of the wedge reseats, trapping any water in the body neck. High-pressure can build up in the body neck if the water is not drained when steam is applied to the valve. The steam heats the water in the body neck causing a dramatic increase in pressure as it flashes to steam. The resulting pressure increase can be catastrophic: the body neck may rupture, the bonnet may be blown off the valve body, or the seat may collapse.

505-9.15.9.1 A flexible wedge or a flexible parallel gate valve such as NAVSEA drawing 803-2177518, oriented in any position (inverted or upright), should have a way to drain liquids that collect in the valve neck. If a drain is not installed, the only means of removing water from the neck is by cycling the valve. For the inverted valve, the wedge or disc entering the neck cavity will displace its own volume of water into the piping system, where it can be drained off. Unfortunately, the water removed from the neck in this way is not enough to prevent over pressurization, because the disc occupies only about 30 percent of the neck cavity. Also, there is no way of preventing some of the displaced water from reentering the neck cavity as the wedge is moved to the closed position. For valves in the upright orientation, cycling the valve will allow the collected liquids to drain by gravity. However, some operating procedures require that the valve and downstream piping be warmed up by bypassing steam around the valve prior to cycling the valve. In this case the trapped liquid in the valve neck can heat up, expand, and cause catastrophic failure. Therefore, a drain line is needed for valves in the upright position.

505-9.15.9.2 Modifications maybe necessary to all inverted and upright flexible wedge and parallel gate valves in steam systems to prevent overpressurization. If these valves already have body neck or bottom drains, no modifications are necessary. The required modifications differ for unidirectional and bi-directional valves.

505-9.15.9.3 A unidirectional valve is any valve that, when closed, will be subjected to a pressure differential from only one direction under any condition. Bi-directional valves can be subjected to a pressure differential in two directions.

505-9.15.9.4 All inverted flexible wedge gate valves (valves installed with the top of their stems located below the wedge) in steam systems having an operating pressure of 600 psi and above require the modifications outlined in paragraph 505-9.15.9.5 through 505-9.15.9.13.

505-9.15.9.5 Provide inverted bi-directional valves with a body neck drain. Installation of this drain shall be according to figure 505-9-4. Locate the drain hole in the lowest part of the body neck. In valves installed with the stem pointing down, locate the drain hole just above the inlay in the body neck (see figure 505-9-4). Provide upright bi-directional valves with a bottom drain located between the two disc seats.

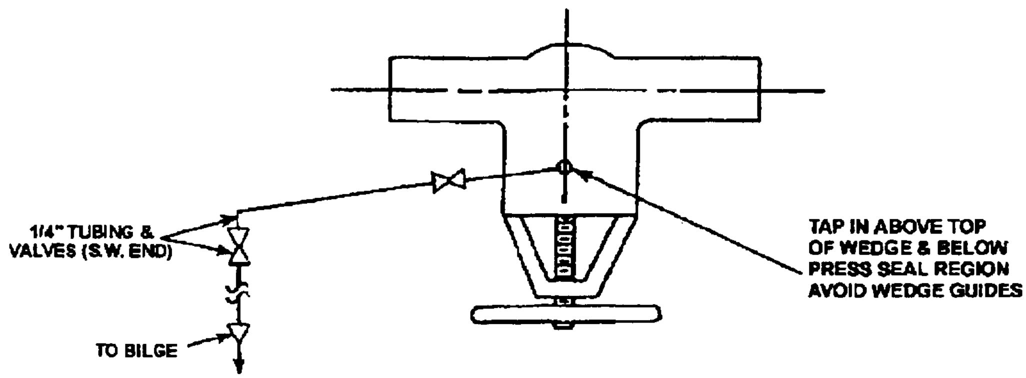


Figure 505-9-4. Body Neck Drain Installation

505-9.15.9.6 Verify that the drain hole location will not interfere with proper valve operation prior to drilling. Drill the drain hole far enough off center to avoid wedge guides inside the valve body. Be careful to avoid drilling into the valve stem or pressure seal area if installing the hole with the valve partially assembled.

505-9.15.9.7 Flexible gate valves installed in the upright position in which the valve stem is above horizontal should have either drains located at the low point of the valve usually between the inlet and outlet side of the disc or a hole drilled in the upstream side of the disc per paragraph 505-9.16.9.9 or a three-way bypass valve, Navy standard valve drawing number 803-1385965 (carbon steel), as shown in figure 505-9-5.

505-9.15.9.8 The three-way bypass valve takes the connection from the valve neck drain and directs it to either the outlet or inlet side of the valve pipe line. The three-way valve not only helps prevent overpressurization it also serves to equalize the pressure across the valve seats helping seat the valve. This is done by pressurizing the valve neck with pressure from the inlet or outlet pipe line. The three-way bypass valve provides for continuous neck overpressure protection. Also, when the three-way bypass valve stem is in mid-position, it serves as a bypass valve between the inlet and outlet of the gate valve.

505-9.15.9.9 Preheating and stress relieving (as necessary) shall be according to NAVSEA S9074-AR-GIB-010/278, **Welding and Casting Standard** . Drain valves shall be in accordance with NAVSEA DWG. 803-2177525 or 803-5184193. Perform welding according to NAVSEA S9074-AR-GIB-010/278. Drain hole connections into valve bodies shall be according to MIL-STD-22, **Welded Joint Design** . Drain valves and piping shall be 1/4-inch National Pipe Standard. Materials shall be the same as the gate valve body and of suitable thickness for the service.

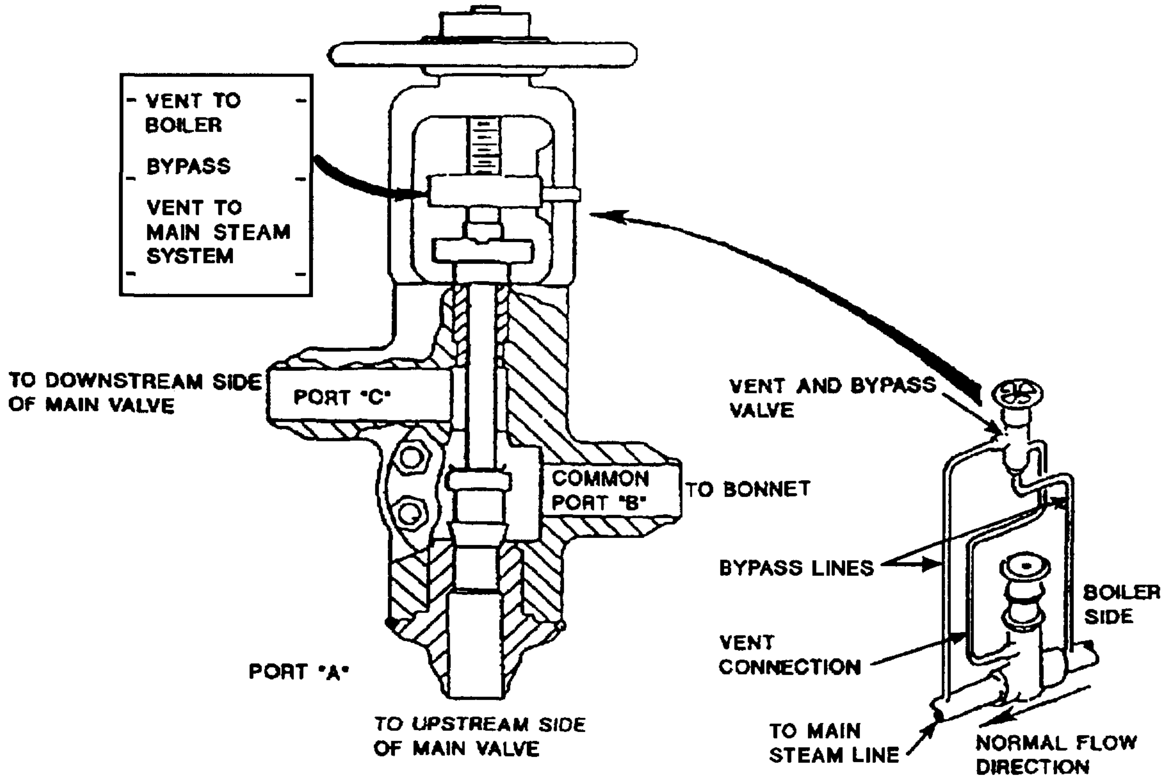


Figure 505-9-5. Three-Way Bypass Valve for Overpressure Protection.

505-9.15.9.10 After completion of the drain installation, attach a plate in a conspicuous location reading: CAUTION - OPEN VALVE BONNET FUNNEL DRAINS BEFORE WARMUP.

NOTE

In some cases, due to the location of the valve, the body may form a natural drain pocket for the attached piping, thereby collecting continuous drainage. Install a trapped or orificed drain to the high-pressure drain main in addition to an atmospheric (funnel) warm-up drain for such installation.

505-9.15.9.11 Either provide unidirectional valves with a body neck drain similar to that for bi-directional valves, or modify them by drilling a hole in the upstream side of the wedge according to figure 505-9-6. Attach a plate in a conspicuous location, reading: THIS VALVE HAS A VENTHOLE IN THE UPSTREAM SIDE OF THE WEDGE. IF WEDGE IS REMOVED MAKE SURE IT IS REPLACED THE SAME WAY.

505-9.15.9.12 This modification for unidirectional valves will prevent overpressurization since the hole provides a constant vent to the upstream piping. Using this type of modification for these valves minimizes the number of drain installations.

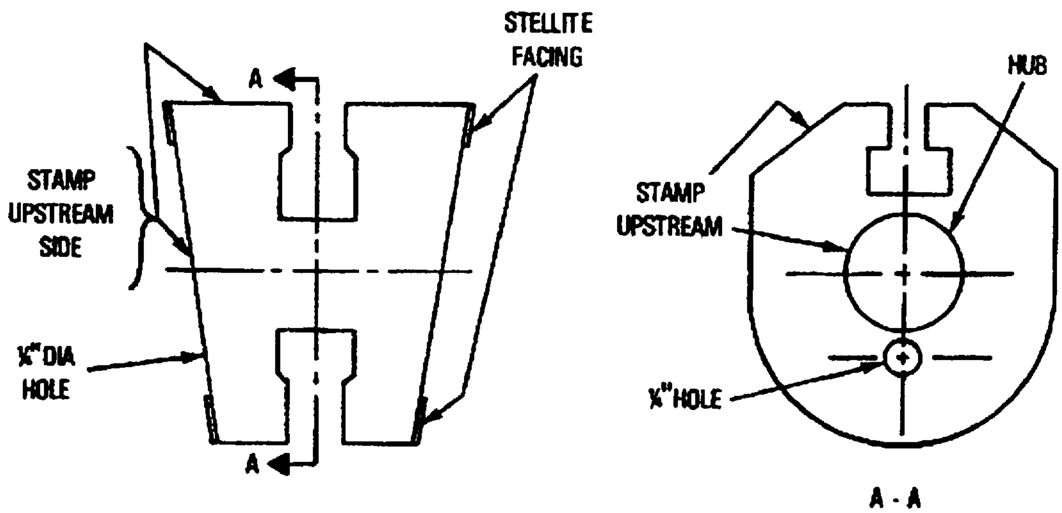


Figure 505-9-6. Flexible Wedge

505-9.15.9.13 Turbine-guarding valve and boiler stop-valve operating procedures result in frequent heating in the closed position and, therefore, the possibility of overpressurization. Valves in this category shall receive priority when modifications are made.

505-9.16 OPERATING INSTRUCTIONS FOR COMBINED EXHAUST AND RELIEF VALVES

WARNING

Immediately before starting turbine, back handwheel fully out to place the valve in the normal operating position.

505-9.16.1 NORMAL OPERATING POSITION. Before starting the turbine, back the handwheel fully out to open the main disc. This position imposes minimum back-pressure on the turbine. Figure 505-9-7 illustrates a combined exhaust and relief valve.

505-9.16.1.1 Admit steam to the turbine as soon as practical after putting the combination exhaust and relief valve (subsequently referred to as the valve) in the normal operating position, to prevent distortion of the turbine rotor.

505-9.16.2 RELIEF POSITION. This position is used during normal turbine shutdown. To place the valve in the relief position, lock the auxiliary valve shut, then rotate the main valve handwheel until the handwheel hub contacts the bonnet yoke. Contact of the handwheel hub and bonnet yoke ensures proper seating of the main valve disc. In the relief position, the spring-loaded main valve disc prevents backflow, but can open to prevent overpressurization of the turbine casing if the turbine is inadvertently started before the valve is placed in the normal operating position.

WARNING

The handwheel hub acts against the bonnet yoke as part of a safety interlock. The handwheel shall be tightly clamped on the stem at all times to ensure functioning of this safety feature. If the handwheel nut loosens, the main valve stem may extend too far into the valve body, inadvertently gagging the main valve disc shut or nearly shut. This will render the pressure-relief feature inoperative, permitting a dangerous casing pressure to build up if the turbine is then inadvertently started with the valve in the RELIEF POSITION.

NOTE

The auxiliary valve is only large enough for protection during startup. At full turbine flow, it will not protect the turbine casing from overpressure.

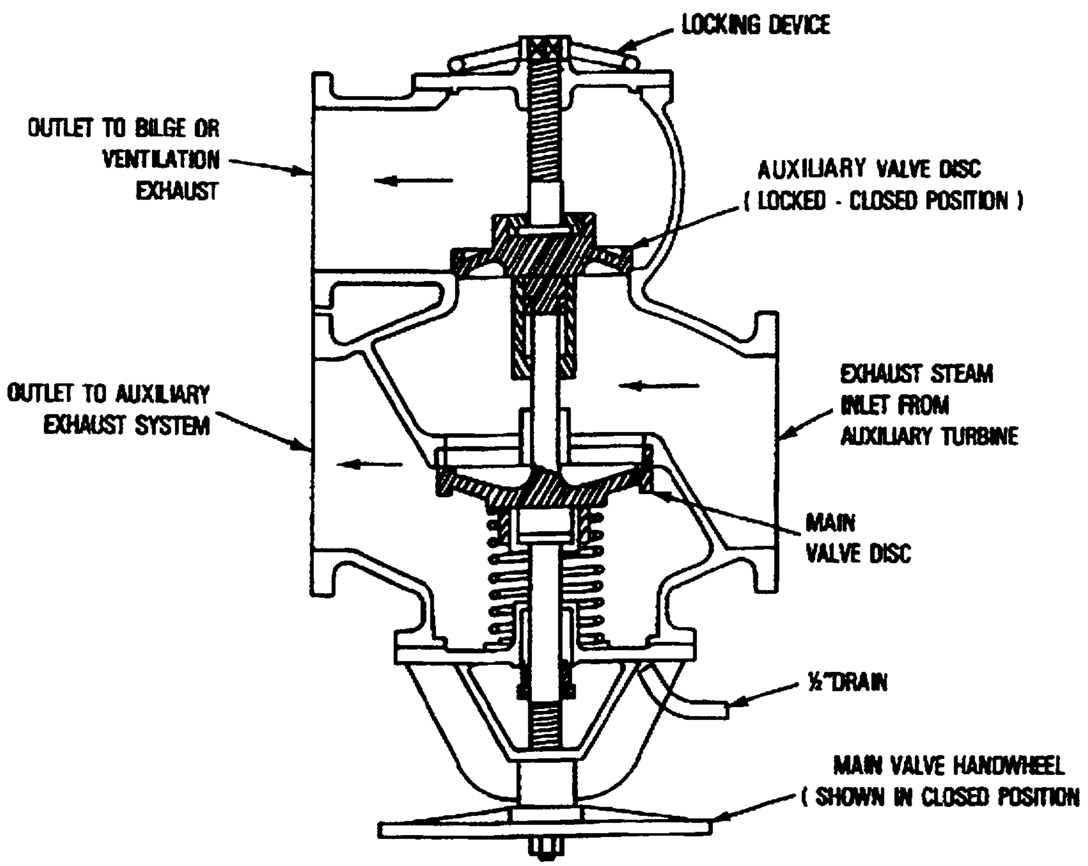


Figure 505-9-7. Combined Exhaust and Relief Valve (Typical)

505-9.16.3 SAFETY POSITION. This position is for turbine overhaul. Turn in and seat the main valve handwheel against the bonnet yoke (RELIEF POSITION). Next, unlock the auxiliary valve and turn the stem fully out. This seats the main valve disc and isolates the normal exhaust system. This also simultaneously unseats the auxiliary disc, providing an emergency steam escape against accidentally dead-heading the turbine. Do not start the turbine with the valve in the SAFETY POSITION. However, should this occur by accident, enough flow is dumped to protect the casing. If such a dump to bilge occurs at startup, immediately shut down the turbine and properly reset the valve to the NORMAL OPERATING POSITION.

WARNING

Before unlocking the auxiliary valve, turn the main valve handwheel in hard against the bonnet yoke.

After completing turbine overhaul, reset the valve from SAFETY POSITION to RELIEF POSITION.

505-9.16.3.1 If steam appears at the telltale connection or at the auxiliary valve discharge pipe when the turbine is started, the valve is in the SAFETY POSITION instead of the NORMAL OPERATING POSITION. Before restarting, immediately shut down the turbine and reset the valve to the NORMAL OPERATING POSITION. The auxiliary port is not sized to protect the casing if the turbine is brought up to full flow. Correct any obstructions interfering with valve operation.

505-9.16.3.2 If the valves are not provided with operating and warning plates, such plates shall be installed. The information may be combined in one plate and permanently attached to a suitable location on or immediately adjacent to the valve.

505-9.16.3.3 NAVSHIPS DWG's 5000-S4824-1385797 and 5000-S4824-1385798 require the use of a prevailing-torque type locknut to fasten the handwheel to the stem, backed up by a pin cross through either the handwheel or lock nut. On valves where these features are not presently incorporated, provide them.

505-9.16.3.4 Install these valves with the handwheel down to prevent corrosion of the auxiliary valve and to properly balance forces on the main valve disc. The auxiliary valve discharge pipe shall be independent of other valves or equipment discharges to prevent accidental exhaust backup into a turbine or equipment being worked on. The piping arrangement shall permit immediate detection of steam discharge. Where the auxiliary valve piping does not terminate in a manner providing visual indication to personnel operating the turbine, incorporate a suitable telltale connection as indicated in figure 505-9-8.

WARNING

Piping from the auxiliary valve (overhaul/safety position) shall discharge to the bilge or other area where it will not be hazardous to personnel or equipment. Each discharge shall be independent (not combined with other valves or services). Provide each auxiliary valve discharge piping with a telltale connection attached to the top of the piping. Telltale piping shall terminate in a covered funnel located within view of personnel operating auxiliary turbine. Connect the low point drain piping, if required, to the waste water system.

505-9.16.4 MAINTENANCE. Perform maintenance and inspection of the combined exhaust and relief valves according to the applicable MRC. This shall include quarterly manual cycling of the main and auxiliary valves to ensure freedom of operation and a pressure cycling of the main valve relief feature.

505-9.17 RELIEF VALVE INSTALLATIONS

505-9.17.1 GENERAL. Pressure relief valves protect piping systems and equipment from overpressure damage by allowing discharge of fluid. Installation shall prevent relief valves from becoming isolated from the protected system or equipment. Set points shall be according to system diagrams. Relief valve blowdown (the inlet pressure decrease, below-lift pressure, required for a discharging valve to reseat) shall be small enough to reseat above the system maximum operating pressure, but large enough to prevent valve chattering during discharge.

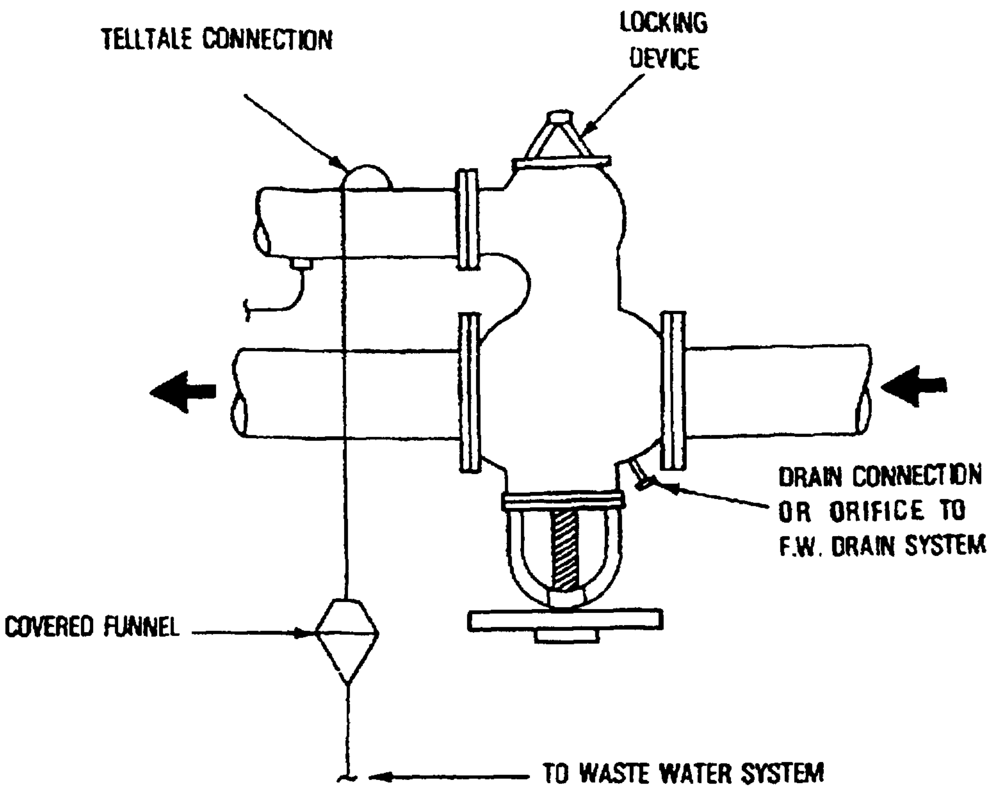


Figure 505-9-8. Combined Exhaust and Relief Valve Telltale and Drain Plug

505-9.17.2 BALANCED VALVE. A special balanced-type relief valve is required where high back-pressure can exist, or where the valve may be subjected to a variable superimposed back-pressure (an exhaust line pressure existing before valve lift).

505-9.17.3 INSTALLATION. Install relief valves upright in a location accessible for inspection, adjustment, and repair. Relief valve discharge piping shall not stress the valve body and shall discharge where it does not create a hazard to personnel or equipment. Avoid long or restrictive inlet and outlet piping. It can cause high-pressure drops and unstable operation. At full flow, inlet pressure loss generally shall not exceed 25 percent of blowdown, and discharge pressure shall not exceed 10 percent of set point pressure.

505-9.17.4 LEAKAGE INSPECTION. Periodically inspect relief valves for leakage, and external corrosion or damage. Whenever the valve undergoes a repair or adjustment that affects operation, verify the proper set point. Where the system cannot be over pressurized for test purposes, remove and shop-test the valve.

505-9.17.5 RELIEF VALVE TEST FREQUENCY.

505-9.17.5.1 Purpose of periodic testing of relief valves is to ensure that they will lift at their set points to protect system components during a system over pressure condition. However unnecessary testing of relief valves should be avoided since it can result in premature relief valve failures. Periodic hand lifting or pressure lifting of relief valves is necessary in systems where operational experience indicates that solids will accumulate beneath the seat of the valve and reduce the relieving capacity, or where operational experience indicates that the valves can stick shut. Set point testing may also be warranted because of the consequences of the relief valve not lifting within set point drift.

505-9.17.5.2 Requirements. Where PMS has been implemented, relief valve testing shall be conducted in accordance with the MRCs. Where PMS has not been implemented, the following inspection requirements can be used as a starting point in developing a maintenance schedule. Testing intervals should be adjusted based on operational experience and actual testing failures in order to achieve the required degree of reliability for the valve. Additional guidance for refrigerant system relief valves is contained in NSTM Chapter 516, Refrigeration Systems.

WARNING

Relief valves in the fuel systems shall not be hand lifted. Tag out in accordance with NAVSEA S0400-AD-URM-010/TUM, TAG-OUT USERS MANUAL any hand lifting devices until the relief valves can be modified by a repair activity to remove the lifting device and plug the resultant hole in the cover to maintain the pressure seal. In addition, fuel system relief valves shall have set point verified by in place operational test whenever valve has been removed from the system. Note: fuel systems include Naval Distillate, JP5, Mogas, and similar fuels.

1. At 2years intervals: Hand-lift relief valves that can be hand-lifted, except for relief valve in fuel systems and refrigerant systems . During these lifts, meet the minimum pressure requirement recommended by the vendor or specified in the valve technical manual to avoid damaging the valves.
2. At 2 year intervals; Pressure-lift relief valves that cannot be hand-lifted , except for relief valves in refrigerant systems .
3. At 5 year intervals: Check relief valve set points.

505-9.17.6 LOCATING RELIEF VALVE DISCHARGE LINES. Because of possible flooding, locate relief valve discharge terminals in all water systems (seawater, potable water, feedwater, and so forth) in manned spaces. If this is not feasible, locate them in unmanned spaces readily visible to the roving watch with the discharge over a deck drain. If clear visibility is not possible, identify and specifically include terminals in the roving watch itinerary.

505-9.17.6.1 Wherever possible, relief valve installations shall conform with the valve manufacturer recommendations. Install them in a horizontal run of pipe with the superstructure in a vertical position. Do not locate them in a piping pocket where water and dirt can accumulate. Also, the location shall permit removal of the valve superstructure and working parts without removing the valve from the line.

505-9.18 PRESSURE-REDUCING VALVES

505-9.18.1 Pressure-reducing valves require proper care to function reliably. Inspect and clean in accordance with MRCs; repair in accordance with approved technical directives.

505-9.18.2 Principal causes and remedies of irregular operation are:

1. Adjusting spring has taken a permanent set; readjust or install a new spring if necessary.
2. Diaphragm fails or deforms; in case of failure, install a new diaphragm. In case of deformation within limits, readjust diaphragm spring. It is good practice to invert the diaphragm periodically, thereby prolonging its service life.
3. The pilot or main valve is not tight, causing leakage. This fault is noticed most quickly on lines supplying machinery that requires steam intermittently. During the time when the need for steam is reduced, pressure will build up due to the leak past the valve. In case of a bad leak, the trouble will be apparent under all conditions. The valve may be held off the seat by scale or dirt. In this case, scoring or erosion probably has resulted. Clean the valve and grind/lap in place.
4. Other causes of failure are working parts or ports are gummed up with oil or dirt, piston ring are stuck, the pilot valve stem is too short due to successive grinding in of pilot valve, and springs are broken or permanently set.
5. The cut-out valve is operating rapidly (close to open) immediately upstream of the reducing/regulating valve.

505-9.18.3 Reducing valves have an arrow cast on the valve body to indicate the direction of flow through the valve. Install valves according to this marking to ensure proper operation.

505-9.18.4 Warm up and drain reducing valves before they are adjusted.

505-9.18.5 Cutout valves in the inlet and outlet of a reducing station shall be fully open when the reducing station is in use.

505-9.18.6 Use MIL-HDBK-227 for guidance in installing regulating and control valves.

505-9.19 ASSESMENT OF SURFACE SHIPS SEA CHESTS AND SEA VALVES

505-9.19.1 GENERAL. Prior to ship docking, the engineer officer shall have the sea valves assessed IAW Class Maintenance Plans. Whenever a ship is docked, the engineer officer shall have the sea chest inspected and repair those valves identified as discrepant. Enter the inspection results in the Engineering Deficiency Log and CSMP.

505-9.19.1.1 EQUIPMENT DEFINITIONS:

505-9.19.1.1.1 SEA CHEST: The entire suction or discharge connection to or from the sea extending from the skin of the ship up to but not including the hull or sea valve. Sea chest may be bounded by more than one sea valve. The sea chest includes associated wall surfaces, strainer bars/plates, and zincs.

505-9.19.1.1.2 HULL VALVE: The last valve to the hull penetration or sea chest for those systems which take suction from or discharge to the sea. Hull valves are primarily gate and butterfly valves, with some being globe and check valves.

505-9.19.1.1.3 SEA VALVE: A hull valve that is located BELOW the hull waterline.

505-9.19.2 SEA CHESTS. Whenever the ship has been docked, inspect the flanged connection between the sea chest and hull valve for leaks. Inspect the sea chest, strainer bars, strainer plates, and waster sleeves for corrosion and verify that they are free of marine growth. See paragraph 505-9.20 for additional information regarding waster sleeves. Record result of inspection in the Engineering Log and CSMP, and repair and clean as required. This same assessment can also be performed waterborne as required; however waster sleeves are generally not accessible waterborne.

505-9.19.3 SEA VALVES. Assessment shall be performed in accordance with applicable MRCs where PMS has been implemented. Use the following assessment procedure where PMS has not been implemented. Assess each sea valve that is identified as discrepant whenever the ship is docked.

NOTE

Marine growth on valve seat and disc is the dominant cause of seat leakage in sea valves. For ships without chlorinating system or other bio-fouling systems, periodic cycling of sea valves, either by EOSS or PMS, has been deemed effective.

505-9.19.3.1 Assessment. This assessment should be performed in place while ship is docked, and should include an initial seat and disc cleaning. If cleaning is unable to restore seat tightness, a detailed examination shall be performed. The examination shall include the yoke; yoke rods; securing bolts; the internal parts of the valve such as valve stem, disc, disc-securing device, and threads of the valve stems; and the tightness of the valve.

505-9.19.3.2 Fasteners. Remove at least two of the bolts holding the hull valve to the sea chest for inspection. Sound the remaining bolts with a hammer. If defects are found in any bolts, draw all bolts of the valve for inspection. While all the bolts are drawn, also inspect the gasket and renew as necessary. When sea valves are examined, verify that nickel-copper bolting is installed. Replace wherever brass or bronze bolting exist

NOTE

Nickel-copper bolting is readily distinguished from brass or bronze by color; it resembles carbon steel bolting. Nickel-copper can be distinguished from carbon steel by its relative magnetic properties; it has weak magnetic attraction, whereas carbon steel has strong magnetic attraction.

505-9.19.3.3 Leakage. Inspect stem seal flange gaskets for leakage. Replace seals and gaskets as required.

505-9.19.4 GATE VALVES. When assembling gate valves, the gate shall be in the half-open position before the bonnet bolts are tightened. This ensures alignment of the guides in the valve bonnet and valve body.

505-9.20 SEA CHEST WASTER SLEEVES

505-9.20.1 GENERAL. Sea chest waster sleeves are installed at the transition between ferrous sea chests and nonferrous piping system components. Waster sleeves are designed in accordance with NAVSEA DWG 803-1749026 and are used exclusively on surface ships; they are not used on submarines.

505-9.20.1.1 The need for waster sleeves arose with the use of nonferrous piping system materials in seawater systems. A galvanic cell was formed wherever a transition between ferrous and nonferrous materials occurred.

505-9.20.2 FUNCTION. Waster sleeves are installed to minimize galvanic corrosion of the sea chest.

505-9.20.3 DESIGN CONFIGURATIONS. Various sea chest waster sleeve design configurations are in use. Their characteristics are discussed below.

505-9.20.3.1 Full Flange Design Configuration. Initially, waster sleeves were designed to have flanges similar to the sea chest flange. This design is specified for use in new construction ships by NAVSEA DWG 803-1749026, and is illustrated in figure 505-9-9. The waster sleeve is retained in the sea chest by clamping its flange between the hull valve and sea chest flanges. Electrical contact between the waster sleeve and sea chest occurs through the installed ground straps.

505-9.20.3.1.1 Replacement of flanged waster sleeves requires hull valve removal. Sea valve removal requires dry docking or the use of cofferdams to prevent flooding. Removal of large sea valves is not easily accomplished due to their size and weight. This difficulty led to the development of different waster sleeve design configurations and waster sleeve segmenting.

505-9.20.3.1.2 These development efforts were concentrated on waster sleeves installed in sea chests where replacement could be accomplished from the outboard side, generally sea chests equal to or greater than 28 inches in diameter. Space restrictions prevent outboard replacement of waster sleeves installed in smaller diameter sea chests. Replacement of these waster sleeves must be accomplished from the inboard side and requires dry-docking or the use of cofferdams to prevent flooding.

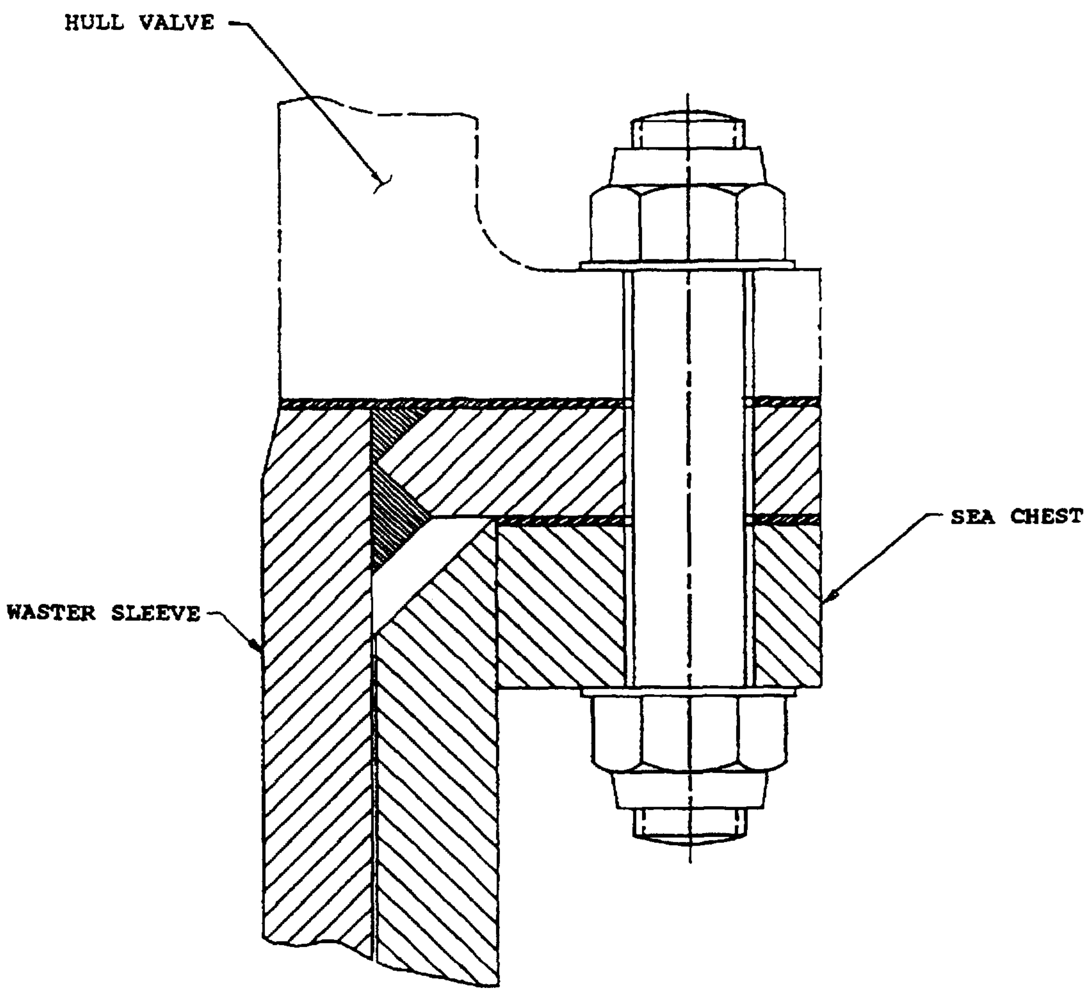


Figure 505-9-9. Full Flange Waster Sleeve

505-9.20.3.2 Pinned Design Configuration. A pinned design configuration was developed to replace waster sleeves in large diameter sea chests without requiring sea valve removal. The configuration is shown in figure 505-9-10. It permits waster sleeve replacement from the outboard side because the waster sleeve flange is not replaced. It remains clamped between the sea valve and sea chest flanges, essentially acting as a thick spacer. Only the cylindrical portion of the waster sleeve is replaced. Replacement is done by cutting the new cylindrical portion into equally sized segments, positioning the segments in the sea chest, then rejoining by vertical seam welds. The waster sleeve segments are attached to the sea chest by pins, as illustrated in figure 505-9-10. These pins are prone to excessive corrosion. Pin failure can lead to waster sleeve segments becoming adrift. Therefore, use of pins to retain waster sleeve segments requires NAVSEA approval.

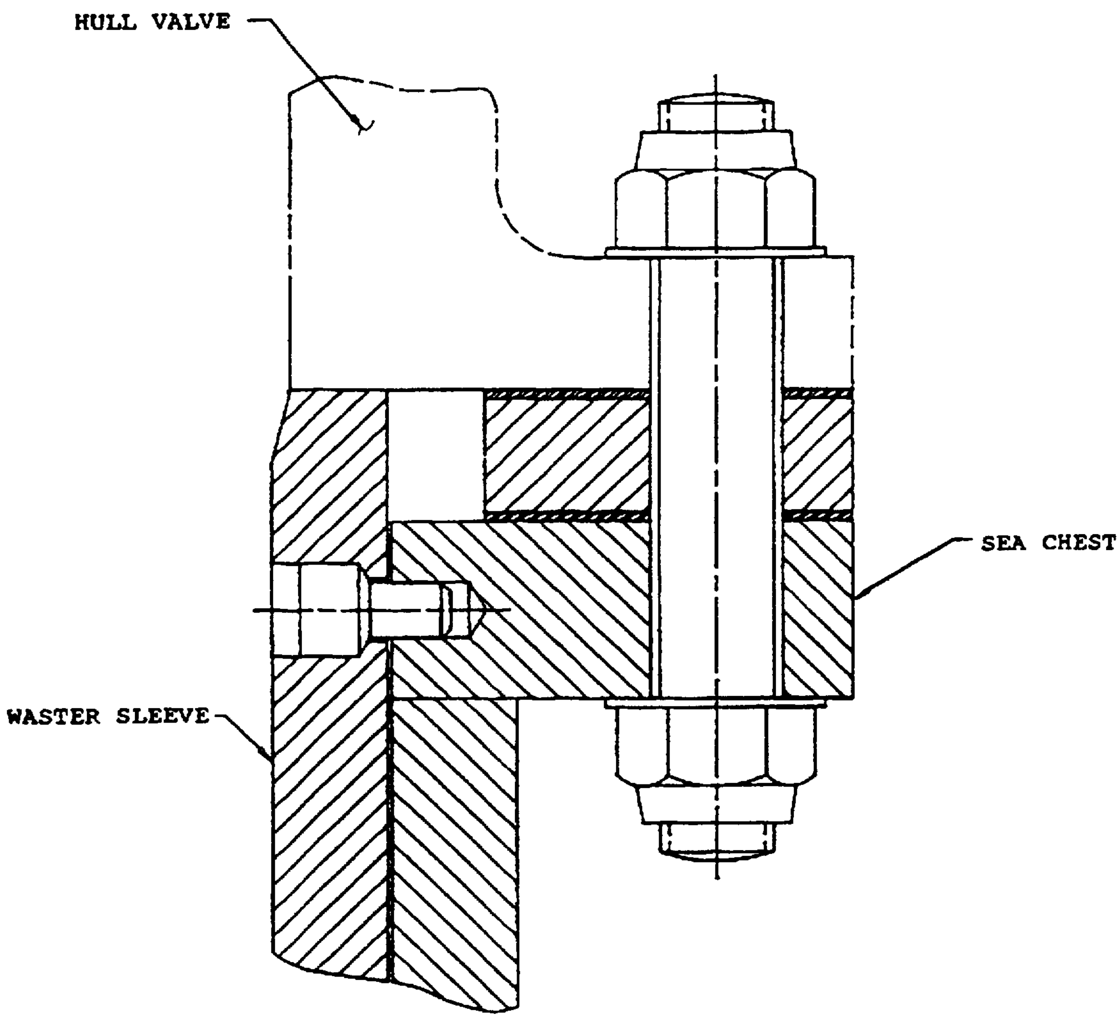


Figure 505-9-10. Pinned Waster Sleeve

505-9.20.3.3 Retainer Ring Design Configuration. The retainer ring design configuration is illustrated in figure 505-9-11. The waster sleeve is retained in the sea chest by the ring machined on the sleeve OD engaging into a mating groove machined in the sea chest. Retainer ring waster sleeves must always be segmented to install them. Segmenting consists of cutting the waster sleeve into equally sized segments, usually four, after machining. The segments are then positioned in the sea chest and rejoined by vertical seam welds.

505-9.20.3.4 Partial Flange Design Configuration. The partial flange design is specified for use in new construction sea chests by NAVSEA DWG 803-1749026. The configuration is illustrated in figure 505-9-12. The waster sleeve is retained in the sea chest by the partial flange resting on the counterbored surface machined in the sea chest flange. Unlike retainer ring waster sleeves, partial flange waster sleeves can be installed as one piece during new ship construction or whenever the sea valve is removed. However, to permit outboard replacement, partial flange waster sleeves are segmented and rejoined in the sea chest by vertical seam welds.

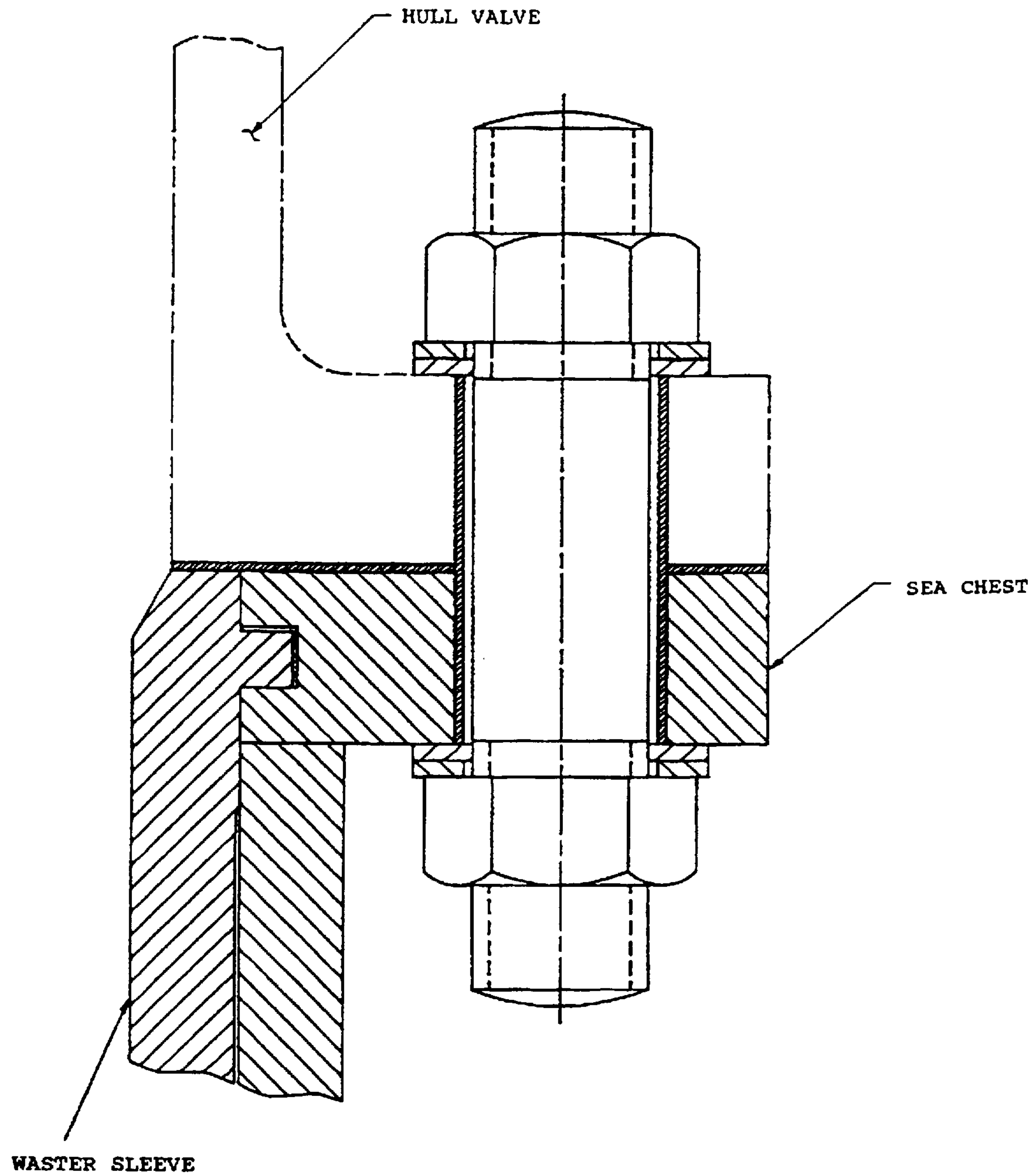


Figure 505-9-11. Retainer Ring Waster Sleeve

505-9.20.4 REPLACEMENT. Refer to applicable ship drawings for detailed information regarding waster sleeve replacement. The following criteria, however, supersede applicable information obtained from ship drawings:

1. Waster sleeve thickness and length shall be in accordance with the latest revision of NAVSEA DWG 803-1749026.

2. Waster sleeves shall be installed as one piece whenever the sea valve is removed.

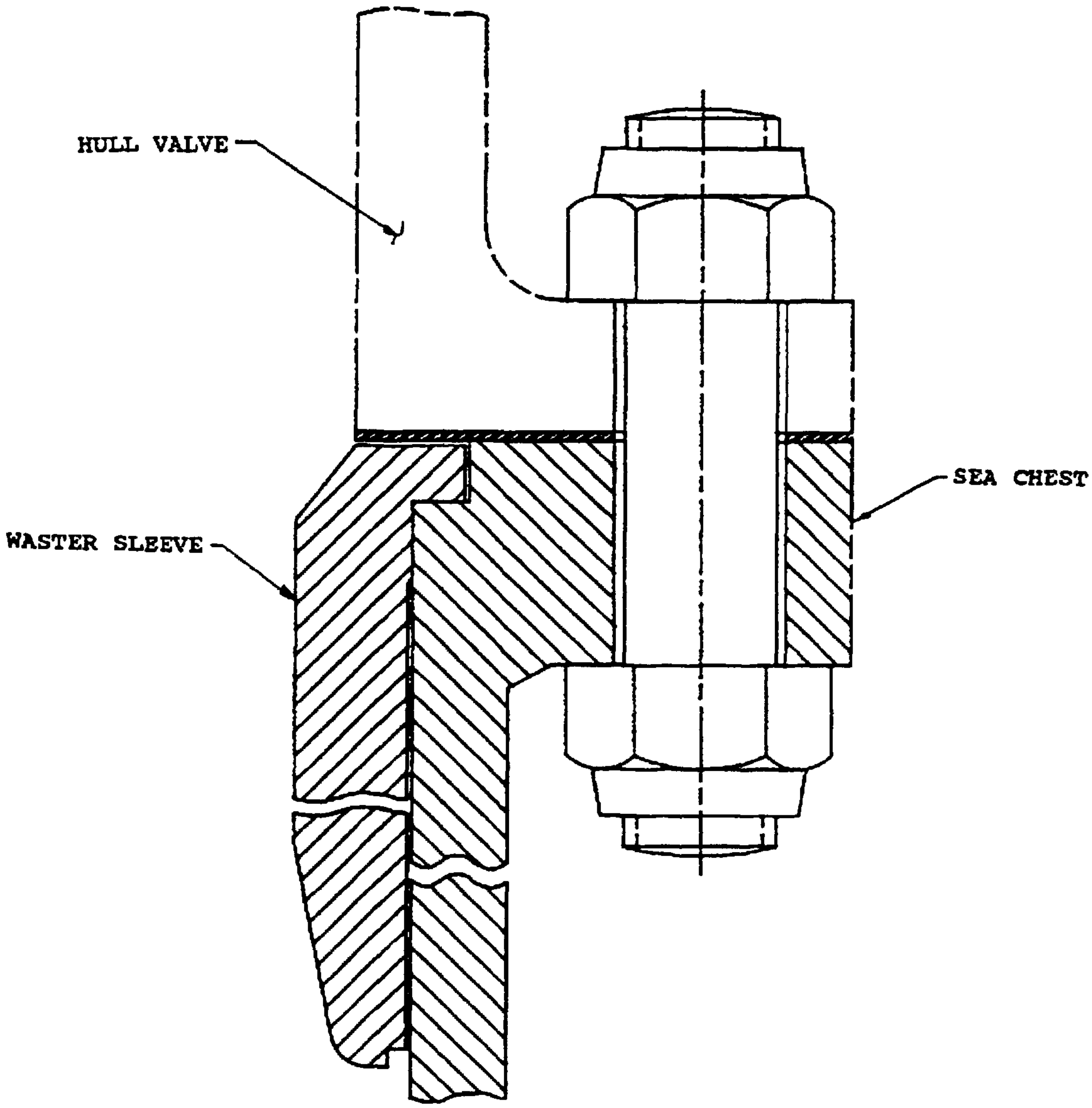


Figure 505-9-12. Partial Flange Waster Sleeve

3. Where segmenting of waster sleeves to facilitate installation in sea chests is necessary, it shall be in accordance with the latest revision of NAVSEA DWG 803-1749026.

4. Weld preparation, welding, and weld inspection shall be in accordance with the latest revision of NAVSEA DWG 803-1749026.

5. Use of pins to retain waster sleeves requires NAVSEA approval.

6. Do not seat partial flange or retainer ring waster sleeves in white lead. Use PR-944-F or equal. PRP-944-F is available from PRC-Desoto International, 5430 San Fernando Road, Glendale, CA 91203, (800) 240-2060.

7. Waster sleeves shall not be welded to the sea chest. A steel strip may be inserted between the waster sleeve OD and sea chest ID to retard burn-through and prevent damage to the sea chest paint.

505-9.20.5 INSPECTION. Inspections shall be performed in accordance with applicable MRCs where PMS has been implemented. Use the following inspection requirements where PMS has not been implemented.

505-9.20.5.1 Frequency. Waster sleeves that require sea valve removal to perform the examinations specified below shall be replaced during planned dry dock availability. Waster sleeves that do not require sea valve removal to perform the examinations specified below shall be inspected whenever the ship is in dry dock. Replace sleeves as required by replacement criteria in section 505-9.20.5.2.

505-9.20.5.2 Replacement Criteria. The following criteria alone is not cause for immediate waster sleeve replacement. Consideration shall be given to elapsed time before the next scheduled dry-dock period before replacing any waster sleeves.

505-9.20.5.2.1 Surface Examinations. Pits having a depth greater than 50 percent of the original sleeve thickness and which are grouped near the top or bottom of the sleeve are cause for replacement. Pitting in these locations may result in portions of the sleeve being ingested into downstream piping components.

505-9.20.5.2.2 Thickness. Waster sleeve thickness equal to or less than 1/8 inch in any location, except as noted above, is cause for replacement. Special attention should be given to the thickness of the welded area of the sleeve.

505-9.21 CLOSING SEA VALVES

505-9.21.1 REPAIRS. Complete repairs undertaken on hull valves as quickly as possible so that the time the valve is disassembled is minimized.

505-9.21.2 IN DOCK. While in dock, close openings in the hull caused by disassembled outboard valves at the end of working hours by replacing valve bonnets and bolting the bonnet securely in place, or by installing blank flanges over the openings. A report that all valves have been closed and bonnets secured shall then be made to the Commanding Officer and entered in the Engineering Log.

505-9.21.3 BEFORE FLOODING. Before a dock is flooded, carefully inspect all outboard valves to verify that they are properly secured. Report the result of this inspection to the Commanding Officer and enter in the Engineering Log and in the Material History Record.

505-9.21.4 WHILE FLOODING. While flooding a dock, continually inspect outboard valves until the ship is afloat and all valves are under a normal working head of water.

505-9.22 TEMPERATURE REGULATING VALVES

505-9.22.1 Temperature regulating valves built to MIL-V-19772A consist of a valve body, adjustment wheel and spring. Attached on top of the valve is a bellows assembly which has capillary tubing and a probe. The probe is usually installed inside piping, air ducts, heaters, or cabinets. The sensing probe can range anywhere from 1 to 3 feet in length and up to 1-1/2 inches in diameter with approximately 2/3 of the volume containing liquid. The remaining volume of the probe, capillary tubing, and bellows assembly contains vapor that expands or contracts. This actuates the temperature regulating valve via the bellows assembly by lifting and lowering the valve stem. Temperature regulating valves of this type are installed on all ship classes and various systems throughout the fleet.

505-9.22.2 Numerous volatile fluids are used in these temperature regulating valve probes. These fluids are extremely flammable and can be hazardous to personnel. These fluids include butane, acetone, ethyl ether, methylene chloride, methyl alcohol, ethyl chloride, and combinations of fluids such as acetone-freon mixtures. These fluids have very low boiling and flash points and under normal conditions are pressurized. The type of fluid used depends on the temperature range and length of the probe.

WARNING

When working on or near temperature regulating valves, observe the following safety precautions:

a. Do not perform any hot work on temperature regulating valve probe assemblies

b. Do not grind on temperature regulating valve probe assemblies.

c. Do not kink probe assembly capillary tubing.

d. Do not smoke, grind, or weld near a temperature regulating valve probe assembly during installation, removal, and repairs.

e. Always wear eye and face protection when installing, removing, and making repairs.

505-9.22.3 Smoking and hot work on or near a temperature regulating valve is dangerous. The capillary tubing is fragile and is subject to breaking. In the event of a compartment fire, the probes can explode. It is important to take the necessary precautions when installing, removing and repairing any temperature regulating valve. The consequences of improper disassembly and handling could be detrimental to equipment and/or personnel. Ships and shore facilities must also take into consideration the storage, handling, and disposal of these probe assemblies in accordance with the appropriate hazardous material directives and technical manuals. NAVSEA S9086-WK-STM-010/CH-670 is the hazardous material technical manual. Section (3) of this technical manual categorizes these refrigerants as either low, moderate, severe, and extreme fire hazards and toxicity. Chapter 593 should also be referred to for pollution control and disposal of hazardous materials.

SECTION 10

MISCELLANEOUS PIPING SYSTEM COMPONENTS

505-10.1 GENERAL

505-10.1.1 Piping system components, including steam traps, strainers, separators, meters, Cascade Orificial Resistive Devices (CORD), hose fittings, and eductors are discussed in this section.

505-10.2 STEAM TRAPS

505-10.2.1 THERMOSTATIC (BELLOWS TYPE). Operation of this trap is controlled by expansion of vapor from a volatile liquid enclosed in a bellows-type element. Use is limited to pressures up to 100 lb/in.^{2}. They are satisfactory for use in draining the constant service steam system, intermittent service steam system (except ventilation preheaters), auxiliary exhaust system, and some oil heating steam systems. This type trap requires as much as 22 degrees C (40 degrees F) temperature differential to operate, depending on the class of trap. In most instances, a cooling leg of pipe is provided between the trap and the unit drained to facilitate drainage. The traps are lightweight, having a compact design in accordance with MIL-T-2118, Trap, Steam, Angle, Thermostatic.

505-10.2.2 OPEN BUCKET, INVERTED BUCKET, AND BALL FLOAT. Operation of these traps is regulated by the condensate level in the trap body. Their use is limited to pressures up to 150 lb/in.^{2}. They are satisfactory for use in draining the constant service steam system, intermittent service steam system (except ventilation preheaters), and oil heating steam systems (except fuel service heaters). These traps are generally heavier and require more space than the thermostatic trap. They are in accordance with MIL-T-960, Traps, Steam, Intermittent Discharge and Continuous Flow, Naval Shipboard, type I.

505-10.2.3 PULSATING. There are two general types of pulsating continuous flow traps used in steam drain collecting systems: the thermodynamic or impulse type and the bimetallic element type.

505-10.2.3.1 Thermodynamic. Operation of the thermodynamic trap is based on principles governing the flow of fluids through orifices in series. Because of this, its use is limited to services where the back-pressure on the trap is not more than 25 percent of the trap inlet pressure.

505-10.2.3.1.1 A small amount of steam leaks through this trap when no condensate is present, as when underway with steam flowing and with the steam lines drained. It is possible to build up pressure in the drain collecting system under this condition. If this occurs, secure certain nonvital traps to limit the drain system pressure.

505-10.2.3.2 Bimetallic Element. The bimetallic element trap operates when the fluid temperature acts on the element. The trap closes when steam is present or opens if condensate is present.

505-10.2.3.2.1 These traps are used primarily for draining main and auxiliary steam lines, but they can be used in other services, under proper conditions. They are in accordance with MIL-T-960, type II.

505-10.2.4 CONTINUOUS FLOW. This type of trap has no moving parts and consists of fixed orifices in series. Because of this, it cannot adjust itself to a widely changing rate of condensate formation. Its use is restricted to services where the condensate rate is relatively constant such as ventilation preheaters, constant service steam systems, oil heating systems, and whistle and jacket drainage. Do not use it for services where condensate formation is not continuous. They are in accordance with MIL-T-960, type III.

505-10.2.5 HIGH-PRESSURE DRAIN ORIFICE. A large number of high-pressure drain orifices according to MS 18301 have been installed by Ship Alteration (SHIPALT) as a replacement for MIL-T-960 type II traps. These devices do not have the same operating characteristics as the traps they replaced; follow the SHIPALTs in determining applications. Drain orifice planned maintenance shall be in compliance with applicable Maintenance Requirement Cards (MRCs).

505-10.2.5.1 Orifices are installed between two flanges (see figure 505-10-1) in the line where traps were previously installed to provide a small continuous drain at each location.

505-10.2.5.2 Orifices are sized and selected to remove the designed condensate from piping systems and equipments. Orifice sizing charts have been provided with each SHIPALT. To prevent clogging of the orifice in low-pressure systems, the minimum orifice size to be used is 0.031 inch.

505-10.2.5.3 Drain orifices are available from stock in an installation kit consisting of a strainer/gasket, an orifice plate, a spiral-wound gasket, and a maintenance kit consisting of a strainer/gasket and spiral-wound gasket.

505-10.2.5.4 Initially, strainers were flat. However, dome-shaped strainers were subsequently found to be more effective. Consequently, use flat strainers until supplies are exhausted and dome-shaped strainers are procured.

NOTE

To prevent clogging of the orifice, the strainer gasket assembly is installed upstream (in front of) of the orifice plate.

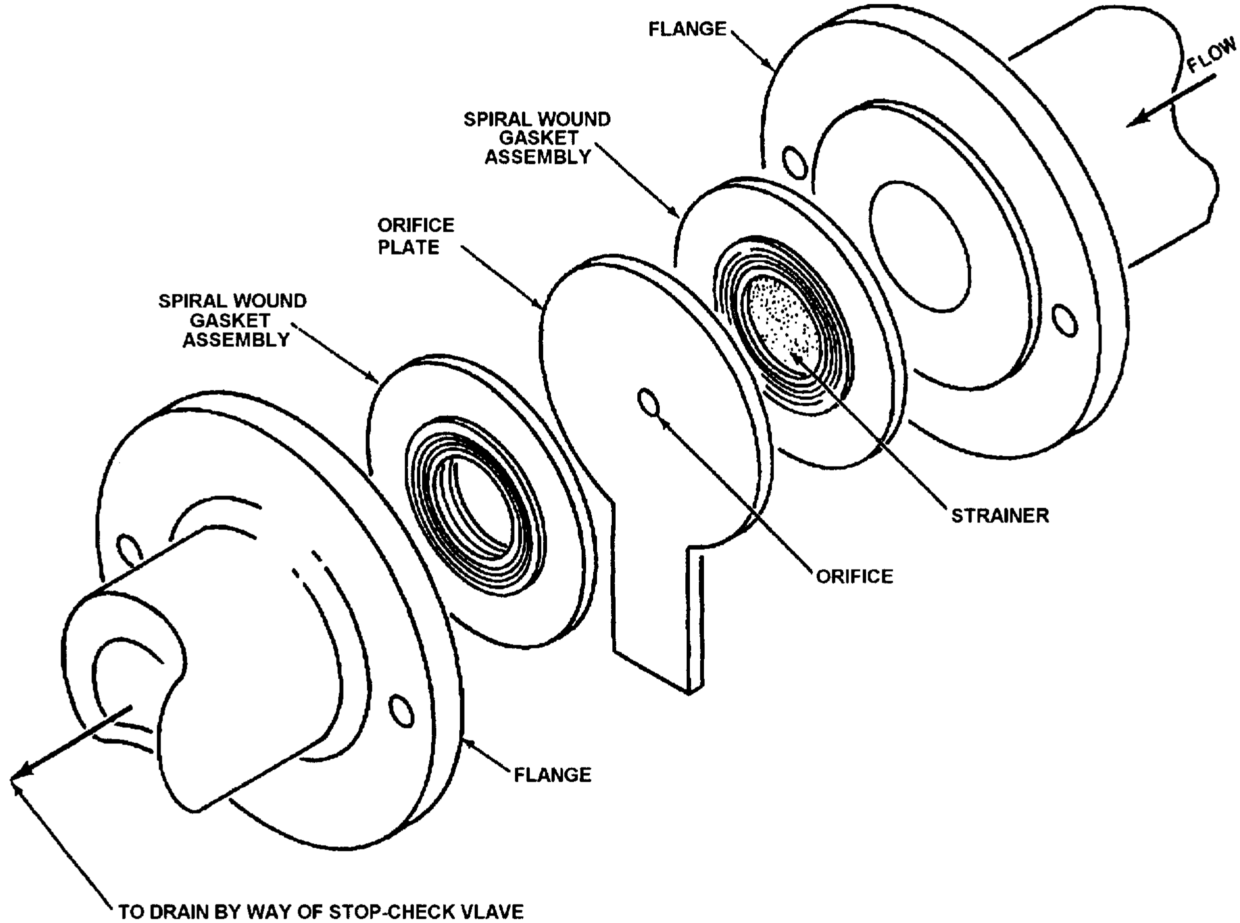


Figure 505-10-1. Drain Orifice Assembly

505-10.2.5.5 Another drain strainer/orifice design is shown on NAVSEA drawing 803-5001057. This design consists of a body with socket-weld end connections and a bolted on cap, containing a strainer and an orifice. See NAVSEA 0948-LP-012-5000, **Standard Navy Valves** , for additional information.

505-10.2.6 LOCATION. Locate traps and orifices below the lowest point to be drained and place them to be easily accessible for inspection and repair.

505-10.2.7 DISCHARGE. The height that a steam trap can lift condensate depends entirely upon the operating pressure and the amount of back-pressure in the drainage system. For practical purposes, a trap will discharge condensate against a head of 24 inches of water for each lb/in. ^{2} of pressure differential between the trap and the drainage system.

505-10.2.8 INEFFICIENT OPERATION. An inefficient trap wastes a large amount of steam. In addition to wasting fuel, steam leakage increases back-pressure in the drainage system with a consequent reduction in system capacity. The principal causes of inefficient trap operation and their correction are discussed in the following paragraphs.

505-10.2.8.1 Leaking Discharge Valves. Discharge valves will leak if the seating surfaces have been damaged by erosion, scale, or dirt. Repair the valve by either lapping, machining and lapping the seat/disk or replacing the seat/disk as required.

505-10.2.8.2 Punctures. Repair or replace a punctured float or bucket.

505-10.2.8.3 Parts Adrift. Secure adrift working parts as required.

505-10.2.8.4 Discharge Valve Too Small. If a discharge valve is too small, install a trap having the proper capacity, direct part of the condensate to another trap capable of handling additional water, or use the bypass if the condition is only temporary. If the trouble is permanent, enlarge the discharge orifice, if the float leverage will handle a large valve, and fit a new discharge valve or install a trap of proper capacity.

505-10.2.8.4.1 In every trap there is a designed relation between the lever ratio and the size of the discharge valve it will operate. The valve will not open if its internal load exceeds the pulling power of the trap. This is the reason why some traps, which work efficiently at low pressure, fail when the pressure rises in the lines being drained. In such cases, it may be possible to adjust the lever mechanism to give more power or to reduce the discharge valve area, if it is larger than necessary.

505-10.2.8.5 Improperly Seated Valve. If the valve does not seat properly, disassemble and clean the trap. When dirt or scale is caught under the valve, use of the hand-tripping device usually will dislodge it.

505-10.2.8.6 Air Bound. If the trap becomes air bound, relieve it by opening the air cock. When putting a cold trap into service, leave air cock open until steam or water issues from it. If large quantities of air frequently pass through, it may be advantageous to leave the air cock slightly cracked or install an automatic air cock.

505-10.2.8.7 Sediment. Sediment in the bottom of the trap may prevent proper operation. When this occurs, blow out the trap, if so fitted; otherwise, disassemble and clean the trap.

505-10.2.8.8 Dry Bucket Trap. Inverted bucket traps do not accumulate enough water to close. They have to be primed (filled with water) to operate properly. Normally, there is enough condensate in the pipe line to prime the trap when the steam is turned on. Occasionally, trouble may be experienced with traps serving lines that contain very little condensate. To remedy this, shut the valve on the discharge side of the trap until the trap body fills with water. This may take as long as 30 minutes. A quick method of priming is to pour water through the inlet connection until the trap is full.

505-10.2.8.9 Thermal Insulation. Inefficient drainage may also be caused by excessive condensate formation if thermal insulation on the steam piping were missing or damaged. Missing or damaged insulation should be replaced.

505-10.2.9 INDICATION OF INEFFICIENT OPERATION. Inefficient operation is indicated as described in the following paragraphs.

505-10.2.9.1 Deaerating Feed Tanks. An increase in air accumulation or temperature are signs of leaking traps in drain systems connected to deaerating feed tanks.

505-10.2.9.2 Drain Systems. An increase in drain system pressure is a sign of leaking traps. The malfunctioning trap(s) can be located by securing traps one at a time and observing system pressure. A leaking trap will cause a reduction in system pressure when it is secured. When a trap is removed for repair, note the condition of its cutout valve. Schedule maintenance as required.

505-10.2.10 INSPECTION. Quarterly, check the operation of all traps in use. Traps with audible working parts may be checked by ear. Repair leaking traps at once. Take particular care to keep clean strainers located ahead of the traps. Perform steam trap planned maintenance according to applicable MRCs.

505-10.2.11 VALVE AND VALVE SEAT REPLACEMENT. Replace trap valves and valve seats prone to damage by erosion with new ones made of nickel-copper alloy or steel faced with chromium-cobalt alloy.

505-10.2.12 SIZING. Steam traps are sized for the condensate expected under service conditions. This minimizes the possibility of abnormal wear and excessive maintenance due to their being oversized. However, a minimum trap size of 1/2-inch nominal pipe size (NPS) is required, since smaller sizes are too easily plugged by dirt and scale accumulations.

505-10.2.12.1 A trap that has rendered satisfactory service may be overloaded by piping alterations that lead additional drains to it. As a temporary measure only, undersized traps can render efficient service by cracking the bypass open just enough to carry off excess water. Exercise caution when operating a trap in this manner, as the bypass valve will pass steam if the quantity of condensate to be handled diminishes.

505-10.2.13 ALTERATIONS. In making repairs or alterations to traps, never change the weight of the float or bucket, unless it has been ascertained that such a change will not interfere with the proper operation of the trap.

505-10.3 STRAINERS AND SEPARATORS

505-10.3.1 STRAINERS. Strainers are installed in piping systems to prevent passage of foreign matter that may obstruct or damage downstream piping components, turbine blading, gearing, or other system machinery. Strainers should always be operated in accordance with applicable procedures, operating instructions, and safety precautions outlined in the Engineering Operational Sequencing System (EOSS). Where Planned Maintenance System (PMS) is installed, perform scheduled maintenance according to applicable MRCs. There are many different types of strainers used on Navy ships. Generally strainers are classified as simplex or duplex. Simplex strainers contain a single screen element. Duplex strainers contain two screen elements which allows one screen element to be removed for cleaning while the other screen element remains in service. Strainers are further categorized as taper plug, Y-type, firesafe, self-cleaning, etc.

505-10.3.1.1 Taper Plug Strainers. ″Taper plug″ refers to the shape of the transfer valve in duplex strainers. These strainers are being phased out of service on Navy ships because of leakage problems inherent with taper plug design. It is difficult to obtain a good seal with taper plugs due to the large surface area which forms the sealing surface. Taper plugs also tend to freeze-up, especially in seawater, thus requiring a jacking mechanism to lift the plug off the seat before plug can be rotated.

505-10.3.1.2 Firesafe Strainers. ″Firesafe″ refers to safety features incorporated into flammable fluid strainer design to reduce the risk of fire. Because of these features, firesafe strainers do not require a safety shield. Typical safety features include:

1. Spray deflectors which direct fluid downward in the event of gasket or O-ring failure.
2. Interlocks which prevent shifting duplex strainers when off-duty strainer cover is removed.
3. Interlocks which prevent removal of strainer cover on strainer compartment in service.
4. Interlocks which prevent opening vent or drain valves of strainer compartment in service.

505-10.3.1.3 Self-cleaning Strainers. ″Self-cleaning″ refers to a strainer design where screen elements are not removed for cleaning. Self-cleaning strainers can be automatic or manually operated. Automatic self-cleaning strainers utilize electrical or mechanical actuators to clean screen elements and require no operator action. Manually operated self-cleaning strainers require the operator to rotate either the screen element or scrapper, depending on design, to remove debris. Operator must then flush debris from strainer.

505-10.3.1.4 Simplex Strainers. The simplex strainer is installed so that fluid flows through a single perforated screen element. Simplex strainers, requiring system shutdown for cleaning, are being selectively phased out. They are being replaced by the self-cleaning strainers shown in Table 505-10-1.

Table 505-10-1. Self-Cleaning Simplex Strainers

Specification	Service	Pressure Rating	Perforation Size
A-A-50632 Continuos self-cleaning simplex strainer	Fuel and Lube Oil	150, 300 & 600 PSIG	25, 40 & 75 Micron
A-A-50633 Self-cleaning pipeline sediment strainer	Seawater	150 & 250 PSIG	1/32, 1/16, 3/32, 1/8, 3/16 & 1/4 Inch

505-10.3.1.4.1 Fuel Service (Tank Fill Lines). Simplex strainers have been provided in fuel service tank fill lines for some ship classes (see NSTM Chapter 541, **Ship Fuel and Fuel Systems**). These strainer elements normally have 4-mil (0.004-inch) perforations. Simplex fuel strainers installed in fill lines during the initial stages of naval distillate conversion programs were provided with screen elements having large perforations. To meet the 4-mil requirement, liners were installed within these elements. This has since proved to be unsatisfactory. Accordingly, ships have been given authority to replace these screen elements with a heavy duty type having the following specifications:

1. Nickel-copper construction
2. 4-mil slotted perforations
3. An element pressure rating equal to or greater than fuel transfer pump maximum discharge pressure
4. Clean element pressure drop of 7 psi or less when using distilled fuel.

505-10.3.1.4.2 Steam Strainers. Steam strainers are defined by MIL-S-21427, **Strainer, Assemblies, Main Steam, High Pressure (Sizes 4 Inches and Above)** , MIL-S-2953, **Strainers, Steam (Sizes 3 Inches and Below)** ; and DWG. 803-841499. Inspect main steam strainers in each propulsion plant for cleanliness and defects during post-shakedown availability, during each regular shipyard overhaul, or upon completion of the first operating period after performing any repairs on the main steam piping or valves. Inspect smaller strainers in the auxiliary steam lines at least quarterly. Planned maintenance for steam strainers shall be according to applicable MRCs.

505-10.3.1.5 Duplex Strainers. Duplex strainers are defined in MIL-S-17849, **Strainers, Sediment, Pipeline, Duplex (With and Without Magnets)** for various piping system applications. Duplex strainers have two screen elements and incorporate a transfer valve to divert fluid flow from one strainer compartment to the other. The most common transfer valve designs are ball valve, taper plug, and double disk.

505-10.3.1.5.1 Ball Valve Type Duplex Strainers. Most firesafe fuel and lube oil duplex strainer designs utilize ball valves to divert flow between strainer compartments. While many different ball valve type duplex strainers are installed on Navy ships, NAVSEA has developed a standard firesafe duplex strainer design. Strainer features and operation are discussed in the technical manuals shown in table 505-10-2. These strainers meet the requirements for classification as firesafe and therefore do not require a safety shield enclosure in accordance with

NAVSEA 0948-LP-102-2010, **Fuel and Lube Oil Strainer Safety Shield Design Guidance** . Any leakage to the off-duty strainer compartment is undesirable and should be corrected. The presence of leakage, however, does not affect operation of the unit nor does it present a safety hazard. Maintenance requirements can be obtained from applicable MRCs. Repair procedures are discussed in the appropriate technical repair standard listed in Table 505-10-2.

505-10.3.1.5.1.1 The original NAVSEA firesafe fuel oil strainer (FSFOS) design has been modified due to several failures which resulted in propulsion plant fuel system casualties. MACHALT 261-48005 modified the design of the wiper shaft to eliminate potential shaft ejection due to fluid pressure. Only one end of the wiper shaft passes through the basket housing. As a result, fluid pressure acts on the other end of the shaft and tries to eject it through the basket cover. In the original design, a collar was pinned to the shaft to prevent ejection. The shaft can be ejected if the pin fails, is not replaced, or an improper replacement pin is installed. In the new design, the collar is an integral part of the shaft, eliminating potential shaft ejection. Additionally, recent fuel system overpressurization on two Navy ships resulted in failure of the FSFOS bottom cover fasteners. As part of the corrective action to insure safe fuel system operation, MRCs are being modified to accomplish the following:

1. Annually check torque on FSFOS bottom cover plate fasteners.
2. Where nuts have less than 25 foot pounds of torque, studs shall be removed and measured for elongation.
3. Replace all elongated studs.

Table 505-10-2. Firesafe Duplex Strainers (For Surface Ships Only)

Service	NAVSEA Drawing	Technical Manual	Technical Repair Standard
Fuel	803-5001048	S9261-AN-MMA-010	S9261-AN-TRS-010
Lube Oil	803-6397390	S6437-A8-MMA-010	S6437-A6-TRS-010
Lube Oil	803-6397396	S6437-A9-MMA-010	S6437-A7-TRS-010
Lube Oil	803-6397291	S6437-A1-MMA-010	S6437-A3-TRS-010

505-10.3.1.5.2 Taper Plug Valve Type Duplex Strainers. Duplex strainers with taper plug transfer valves are most pervasive in seawater system applications. These strainers can also be found in many lube oil and some fuel system applications. As previously noted, taper plug valves are notorious for freeze-up and leakage to the off-duty strainer compartment. Leakage can be severe enough to prevent removal of the off-duty screen element for cleaning. Therefore, these strainers are gradually being replaced by self-cleaning simplex strainers as described in 505-10.3.1.

505-10.3.1.5.2.1 Taper plug valve leakage criteria.

1. New duplex strainers utilizing a taper plug transfer valve shall exhibit zero leakage.
2. During strainer operation, allowable taper plug valve leakage depends on system fluid. Strainers which exceed the following leakage criteria should be repaired or overhauled.
   a. Fuel and lube oil strainer leakage shall not fill the off-duty strainer compartment within one hour with the drain valve closed (or drain plug installed).
   b. Other fluid system strainers shall not fill the off-duty strainer compartment within one hour with the drain valve open (or drain plug removed).
3. For repaired or overhauled strainers, the desired taper plug valve leakage is zero. However, some leakage is acceptable depending on system fluid.

a. Fuel and lube oil strainer leakage shall not fill the off-duty strainer compartment to more than one-fourth of its height within one hour with the drain valve closed (or drain plug installed).

b. Other fluid system strainers shall not fill the off-duty strainer compartment within one hour with the drain valve closed (or drain plug installed).

c. For submarine trim and drain duplex strainers, refer to TRS 4330-086-004 for additional repair and retest requirements.

NOTE

If fluid continues to flow out of the off-duty vent valve after the drain valve has been opened, do not service the strainer while the system is pressurized. Schedule the strainer for overhaul at the first opportunity.

505-10.3.1.6 Flammable Fluid Strainers. Strainers used in flammable fluid piping systems shall meet the firesafe criteria of 505-10.3.1.2 whenever possible. Fuel and lube oil strainers which are not designated as firesafe require safety shielding in accordance with NAVSEA 0948-LP-102-2010, **Fuel and Lube Oil Strainer Safety Shield Design Guidance** .

505-10.3.1.6.1 Fire Hazard Inspection. To minimize the danger of fire in strainers, assign a qualified engineering department officer to inspect all fuel and lube oil system strainers at routine intervals to determine general mechanical condition of the strainers. Check the following items:

1. Gasket seating surfaces.
2. Cover holddown clamps and studs.
3. Valve integrity.
4. Drainage.
5. Operability without undue force.
6. Condition of strainer element(s).
7. Leakage.
8. Security of the magnets in all lube oil strainers.
9. Integrity of all piping connections.
10. Use of proper cover gasket.
11. Other deficiencies that may exist depending on the individual installation.
12. Drip pan and drain piping from the system to ensure proper free drainage into the contaminated drain system.
13. Safety shields to ensure adequacy of design and safety of operator and equipment during operating and cleaning sequence.
14. Check valves to ensure proper installation and operation.

505-10.3.1.7 Seawater Strainers. Bronze-bodied seawater strainers with rolled commercial brass screen element material proved to be unsatisfactory. Accordingly, ships have been given authority to replace brass screen elements with nickel-copper alloy per ASTM B164 (UNS N04400), **Nickel-Copper Alloy** . If nickel-copper is unobtainable, copper-nickel per ASTM B171 (UNS 70600 or 71500), **Copper-Nickel Alloy** , may be substituted. Vent, drain, and gauge valve connections shall be either straight-threaded unions or boss connections fitted with O-rings. Open-ended valves with a union or boss connection must be secured to prevent accidental rotation of the threaded joint.

505-10.3.1.8 Strainer Gauges. The preferred strainer installation includes a differential pressure gauge connected to the inlet and outlet of the strainer body or adjacent piping. Differential pressure is an indication of strainer element cleanliness and is used to determine when cleaning is required.

505-10.3.1.9 Sea Chest Strainers for Surface Ships. Connection to suction sea chests is provided to clear strainers when obstructed. The connections normally consist of a throttle valve, a relief valve set at 40 psig, bleed connection, pressure gauge, and hose valve.

1. To blow out a sea chest:
   a. Connect a hose between the steam/air supply and the hose valve on the sea chest.
   b. Close the hull valve downstream of the sea chest.
   c. Open the hose valve located on sea chest.
   d. Throttle the steam/air supply valve to a pressure of 35 psig as indicated by the adjacent pressure gauge.
2. To secure the blowing out operation:
   a. Close the steam/air supply throttle valve and the hose valve on the sea chest.
   b. Open the sea chest bleed connection carefully to relieve locked-in steam/air pressure.
   c. Close the hose valve, disconnect the hose, and close the bleed connection.

NOTE

The threaded cap connected to the hose valve when the hose is not connected has a small hole drilled in it. This is a safety feature to prevent pressure buildup if the steam/air throttle valve leaks or is inadvertently opened before the cap is removed.

505-10.3.2 SEPARATORS. Separators operate on the general principle of removing entrained liquids and solids from gases and vapors by using centrifugal force. Steam separators are fitted with vanes, guides, or baffles that impart a whirling motion to the steam. Air system separators are fitted with internal tubes to achieve the same result. The resulting motion forces entrained liquids and solids which have a density greater than the system fluid against the separator wall where they are collected. The system fluid continues unimpeded through the separator. The separated material collects in the separator sump from which it can be drained as necessary. Separators in steam service are provided with trapped drain connections to permit continuous drainage of condensate.

505-10.3.2.1 Moisture Separators. Moisture separators in compressed air service are arranged for manual draining by use of a needle valve. Because of this, regular and periodic blowdown of the moisture separator is mandatory to maintain maximum efficiency and to prevent separator rusting. See NSTM Chapter 551, **Compressed Air Plants** . Planned maintenance for moisture separators shall be according to applicable MRCs. For maximum efficiency, install separators in a straight length of pipe and at least 10-pipe diameters downstream of the nearest valve or fitting.

505-10.4 METERS

505-10.4.1 In newly installed or modified piping systems, flush the line before the meter is installed to minimize possible damage from foreign materials.

505-10.4.2 Where strainers are fitted, clean as required by the nature of the service.

505-10.5 CASCADE ORIFICIAL RESISTIVE DEVICE (CORD)

505-10.5.1 The CORD is a device used to reduce pressure in a piping system by taking a small pressure drop across each of many orifice plates (perforated plates) arranged in series. The net effect is a large pressure drop through the unit with minimum noise generation. A standard design has been developed for surface ships (see NAVSEA DWG 803-5196808).

505-10.5.2 The standard CORD consists of a threaded rod with spacer nuts securing each perforated plate in position. Perforations shall not line up from one plate to the adjacent plate. Positioning rings retain outer edges of plates. Perforated plates used at the outlet end of the CORD have more open area than those used in the inlet end. The CORD is securely retained within a piping spool piece that serves as the CORD body. Stave damping (a technique for optimizing noise attenuation) is applied to the CORD body.

505-10.5.3 The CORD requires periodic disassembly and cleaning. Planned maintenance for CORDs shall be according to MRCs. It is important that all plates with greater open area be installed at the outlet end, that the plates are all tightly retained, and that the perforations in any two adjacent plates do not line up.

505-10.6 FLEXIBLE PIPING DEVICES

505-10.6.1 FLEXIBLE HOSE ASSEMBLIES. Select, fabricate, inspect, install, and maintain flexible hose assemblies according to NAVSEA Technical Directive S6430-AE-TED-010, Volume 1.

505-10.6.2 RUBBER INSERT SOUND ISOLATION COUPLING. Select, inspect, install, and maintain rubber insert, sound isolation coupling, flexible connectors according to NAVSEA Technical Directive S6430-AE-TED-020, Volume 2.

505-10.7 EDUCTORS

505-10.7.1 The widespread use of eductors and their improper installation, test, and operation have contributed to numerous flooding incidents. Operational information is provided to reduce the incidence of flooding casualties.

Ensure that all personnel assigned to operate eductor bilge drainage systems are thoroughly familiar with and follow the operating procedures presented in the following paragraphs.

NOTE

Valve numbers must match diagram numbers.

505-10.7.2 Refer to EOSS for proper operating instructions or place a placard containing instructions consistent with paragraph 505-10.7.6 and paragraph 505-10.7.7 in the vicinity of each eductor.

505-10.7.3 Inspect all bilge drainage suctions to verify that strainers are installed. If strainers are missing, take action to provide and install them.

505-10.7.4 To prevent backflow, all bilge drainage eductor suction lines shall contain a check or stop-check valve. Inspect eductor suction lines and take action to install check valves where they do not already exist. If a check valve is installed in a common suction line serving several tailpipes, it is not necessary to provide a separate valve in each individual tailpipe.

505-10.7.5 Test the valves in eductor drainage systems according to the PMS.

505-10.7.6 Operate the eductor and drainage system as follows (see figure 505-10-2):

a. Open overboard discharge valve number 1.

b. Open fire main actuating water valve number 2.

c. Observe actuating water pressure gauge and regulate valve number 2 to eductor rated operating pressure.

d. Observe eductor suction vacuum pressure gauge. If positive pressure is registered, examine overboard discharge valve number 1 and take corrective measures (this valve shall be wide open while eductor is operating). When vacuum is indicated on the vacuum pressure gauge, open eductor suction valve number 3. Do not open valve number 3 while positive pressure is registered on the vacuum-pressure gauge.

e. Open bilge suction valve number 4 for selected suction tailpipe.

f. Monitor bilge water level.

g. Verify that valve numbers 4, 3, and 1 are wide open.

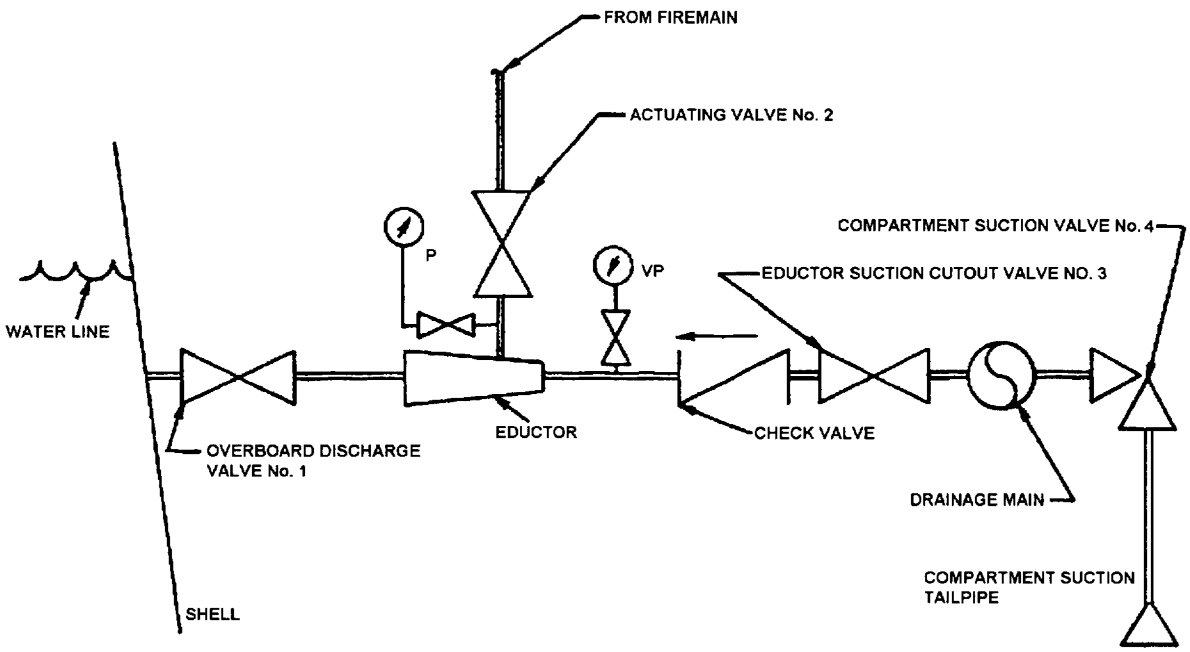


Figure 505-10-2. Eductor Draining System

WARNING

Verify that the space in which the eductor is taking suction is unmanned or adequately vented. Eductors have been known to create a vacuum in the space resulting in unbreathable air and a personnel hazard.

505-10.7.7 To secure eductor and drainage system, proceed as follows:

a. Close bilge suction valve number 4.

b. Close eductor suction valve number 3.

c. Close fire main actuating water valve number 2.

d. Close overboard discharge valve number 1.

e. Check valve numbers 1 through 4 are fully shut. Do not rely on check valves to prevent return flow.

f. Check pressure and vacuum-pressure gauges for rising pressure after all valves are shut. Recheck the gauges after a 10-minute interval to ensure that pressure has not risen since shutoff. Any rise in pressure indicates that adjustment or repair of the fire main actuating water valve number 2 is necessary.

SECTION 11

TESTING

505-11.1 SHIPBOARD HYDROSTATIC TESTS

505-11.1.1. SYSTEM PRESSURE TESTS. Fluid systems are hydrostatically tested during initial construction, and subsequent to repairs, modifications, and component replacement; to verify the leak tightness of the system. Operational pressure tests are performed periodically to determine leak tightness of system mechanical joints. Operational pressure tests are also performed instead of hydrostatic tests, when the criteria of paragraph 505-11.1.2.6 (Operating Pressure Test Option) are met. The basic purpose of all such tests is to ascertain that the system can perform its intended function safely and reliably. Unless otherwise specified, the tests discussed in Section 11 are generally applicable to all nonnuclear piping systems. The requirements of NAVSEA S9505-AF-MMA-010, **Submarine Non-Nuclear Piping System Test Manual** , apply for all tests during fleet repairs of submarine nonnuclear piping systems except as discussed in paragraph 505-11.1.2. Additional or supplemental guidance for testing of special systems is also found in the following: NAVSEA 0902-LP-018-2010, **General Overhaul Specification for Deep Diving SSN/SSBN Submarines** (applies as identified in the availability work package); NAVSEA S9AAO-AB-GOS-010/GSO, **General Specifications for Overhaul of Surface Ships (GSO)** , NAVSEA S9AAO-AB-GOS-020/GSO, **General Specification for Overhaul of Surface Ships, Nuclear Supplement** ; NSTM Chapter 550, **Industrial Gases; Generating, Handling, Storage** ; MIL-STD-1330, **Cleaning and Testing of Shipboard Oxygen Nitrogen, and Hydrogen Gas Piping Systems** ; NSTM Chapter 551, **Compressed Air Plants and Systems** ; NSTM Chapter 556, **Hydraulic Equipment (Power Transmission and Control)** ; NSTM Chapter 542, **Gasoline and JP-5 Fuel Systems** ; and NSTM Chapter 516, **Refrigeration Systems** .

505-11.1.2 POST-REPAIR HYDROSTATIC TESTS. Subsequent to repair or component replacement, subject affected areas of a system to a hydrostatic test to 135 percent of system design pressure (but not less than 50 lb/in.^{2}) with the following exceptions:

505-11.1.2.1 Valve Packing, Pump Packing, and Pump Mechanical Shaft Seals. System hydrostatic testing is not required after replacing valve packing, pump packing, and pump mechanical shaft seals provided the component is tested at nominal operating pressure according to applicable requirements.

505-11.1.2.2 Mechanical Joints.

a. General. Unless otherwise specified, hydrostatic testing of the piping system is not required after disassembly and reassembly of threaded or bolted closures providing the following requirements are satisfied:
   (1) Strength members are not modified.
   (2) Replacement parts are in accordance with applicable requirements.
   (3) Finish of sealing surfaces is within specified limits.
   (4) Replaced component, where applicable, has been shop-tested to 135 percent of the system design pressure.
   (5) Joint is reassembled in accordance with applicable procedures.
   (6) Joint is leak-tested at nominal operating pressure.

NOTE

Replacement of Seals (gaskets, including pressure seal rings and O-rings); joint bolting (bolts, studs, washers, locking devices, and nuts); valve stem and valve stem disk assemblies; and yoke bushings that do not retain the valve stem do not require shop hydrostatic testing of the component, providing the above requirements are satisfied.

(7) Disassembly and reassembly of mechanical joints in open lines requires no specific retest.

b. Instrument Test Cap Connections. Instrument isolation valve stem test cap connections, which are reinstalled for test, calibration, vent or drain application point, are to be visually inspected to ensure seating surfaces are undamaged, then made up tight. No further testing is required. New instrument test cap connections are required to be tested in accordance with paragraph 505-11.1.2.2, except subparagraph 505-11.1.2.2(a)(6) (leak test) is not required on final joint reassembly.

c. ″Bite Type″ Fittings. Replacement of one-half inch and smaller bite-type flareless tube fittings bodies, ferrules, and nuts per MIL-F-18866 does not require hydrostatic testing, provided that the requirements of paragraph 505-11.1.2.2.a (except paragraph 505-11.1.2.2a(4)) are met. Cutting off the end of the tubing where the old ferrule was installed for the purpose of installing a new ferrule is not considered a strength member modification.

505-11.1.2.3 Tank Overflows and Air Escapes. The post-repair tank tightness test shall include overflows and air escapes up to the overboard discharge or connection to a common tank overflow or air escape header. This requirement applies even if the overflow and air escape piping has not been modified. Repaired tank overflow and air escape piping shall be tested to 50 psig or tested with the tank if tank repairs have been made or using the option discussed in sub-paragraph 505-11.1.2.6. After test completion, overflow and air escapes shall be given an unobstructed airflow test to ensure removal of blanks.

505-11.1.2.4 Submarine Sea-Connected Systems. Hydrostatically test all repairs to submarine sea-connected systems, including the bonnet flange on the hull valve. Test at a pressure equal to collapse depth plus pump shutoff pressure, except those portions that have been designed to hull structure criteria for collapse depth where the test pressure shall be equivalent to test depth. See Fleet Test Pressure Diagrams (TPDs) for further information. Procedures for these hydrostatic tests shall be prepared by the repair activity and approved by the Supervisor of Shipbuilding.

a. Where hydrostatic testing is not practical, joint reassembly shall be accomplished in accordance with the following procedures, with specific NAVSEA approval:

(1) Verify that gasket and O-ring sealing surface finishes are according to applicable specifications.

(2) Verify that fastener material and installation are according to applicable specifications.

(3) Verify that gasket and O-ring materials and installation are according to applicable specifications.

(4) Inspect joints visually at each 200-foot increase in depth during the first deep dive.

(5) Provide documentation verifying completion of the foregoing steps and request the necessary departures.

b. Preventive maintenance to inspect or replace seawater heat exchanger pencil and disc type zinc anodes in SSN 688 and later classes may be performed without additional hydrostatic tightness testing provided all the following conditions are satisfied:

(1) The seawater system opening is designed to be closed with an O-ring sealed threaded plug with a nominal diameter of 1-5/8″ or less.

(2) A surfaced condition maximum system operating pressure test is performed with zero leakage.

(3) The REC requirements or NAVSEA 0924-062-0010 and the controlled assembly requirements of the Force Quality Assurance Manual are followed for heat exchangers in the SUBSAFE certification boundary.

(4) No hydrostatic testing is required for other maintenance or repair which would subject the zinc anode maintenance area to at least mechanical joint tightness pressure.

(5) All other Maintenance Requirement Card and drawing requirements are met.

505-11.1.2.5 Vacuum or Atmospheric Systems. Leak-test all repairs to systems that normally operate under vacuum or atmospheric conditions.

505-11.1.2.6 Operating Pressure Test Option. The post repair hydrostatic test may be replaced with a tightness check at system nominal operating pressure using normal system fluid, flushing fluid, or fresh water, as appropriate, (1) for all repairs, modifications, or replacements in reduced energy criteria systems (those operating at 200 psig or less and 200ºF or less), (2) for piping system weld or brazed joint repairs and replacements or welded or brazed joints added as system modifications, or (3) for newly installed ASTM F-1387 Type I, V, or VI MAFs (see paragraph 505-6.8.1). This option does not apply to joints in “lethal” system as defined in NAVSEA 0900-LP-001-7000 or to joints in sea water and sea connected systems or portions thereof, which are subject to submergence pressure below 200 feet or to sections of piping that pass through sea pressure rated bulkheads and which are rated for submergence pressures greater than 200 feet. The following criteria must be met to implement this option:

a. All applicable requirements specified in NAVSEA S9074-AR-GIB-010/278, **Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels** , NAVSEA 0900-LP-001-7000, **Fabrication and Inspection of Brazed Piping Systems** , or the applicable Uniform Industrial Process Instruction (UIPI) or Process Instruction for MAF installation per paragraph 505-6.8.1 must be accomplished. The following additional requirements apply:

   (1) For class P-1 and P-LT welds as defined in NAVSEA S9074-AR-GIB-010/278, **Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels** , PT or MT the root layer of all weld joints (substitution of 5X visual examination, RT, or UT is not permitted for this additional NDT). Additionally, PT the final layer of all weld joints (substitution of MT is not permitted for this additional NDT).

   (2) For class P-2 welds as defined in NAVSEA S9074-AR-GIB-010/278, **Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels** , in systems which exceed the reduced energy criteria of operating conditions of 200°F or 200 psig, PT the final layer of all weld joints (substitution of MT is not permitted for this additional NDT).

b. Conduct a visual inspection of the affected joints for leakage during the first system pressurization to nominal operating pressure using the requirements of paragraph 505-11.1.3.19 and paragraph 505-11.1.3.20.

   (1) For gasoline, JP-5, fuel, and propane systems, a low pressure air tightness check of affected joints shall be accomplished prior to the operating pressure test. The low pressure air tightness check shall be accomplished at 50 psig for systems with normal operating pressure of 50 psig and greater, or at system operating pressure if it is lower than 50 psig.

   (2) For oxygen and hydrogen systems, a tightness test of affected joints in accordance with MIL-STD-1330, **Cleaning and Testing of Shipboard Oxygen, Nitrogen and Hydrogen Gas Piping Systems** , or other approved procedure, shall be accomplished prior to system operation.

   (3) For compressed air and gas systems (other than reduced energy criteria systems, Halon, CO_2 , and Aque-

ous Potassium Carbonate (APC) fire extinguishing systems, and systems specified in subparagraph 2 above), the visual inspection shall be conducted at maximum operating pressure. For air banks with fixed charging pressure that cannot be immediately recharged, the operating pressure test shall be conducted at the current pressure level. If the current level is depleted compared to maximum charging pressure, the operating pressure test shall be conducted again when the bank is fully charged.

(4) For Halon, CO_2 , and APC fire extinguishing systems, the tightness check shall be performed with potable water at the following pressures: Halon discharge piping downstream of stop valves in DDG-51 class and CG-47 class, and in all locations for other ship classes - 1170 psig; Halon discharge piping upstream of stop valves in DDG-51 class (applicable to LM2500 systems) and CG-47 class (applicable to machinery space systems) - 2010 psig; Halon actuation - 2010 psig; and CO_2 fixed flooding or hose reel - 1900 psig; and APC system piping - 350 psig.

(5) For Vacuum, Collection, Holding and Transfer Sewage System (portions under vacuum), the visual-tightness check shall be tested to at least 24 inches of Hg (vacuum) for at least ten minutes with less than 10 percent drop.

c. For joints in piping systems that are not fully pressurized during normal system operation, operated only during ships underway periods, or when pressurization under normal operation does not allow sufficient time to inspect affected joints, the leak testing specified in sub-paragraph 505-11.1.2.6b above is not practical. Also, for joints in systems where the operating fluid is a hot gas (operating temperature greater than 200°F) which will not condense at atmospheric conditions such that locating leaks during operational testing using a leak detection compound in accordance with section 505-1.4.2.1.1 or a mirror to detect condensing vapors is not possible, the leak testing specified in sub-paragraph 505-11.1.2.6b above is not practical. For these cases in reduced energy criteria systems, the leak testing specified in sub-paragraph 505-11.1.2.6b above is not required. For these cases in other systems, temporary equipment must be used to perform the operating pressure test if the operating pressure test option is selected in lieu of performing normal system hydrostatic testing.

NOTE

1. **Choosing this operating pressure test option in lieu of performing an elevated pressure cold hydrostatic test may not be the most cost effective option. The performance of a system operating pressure test utilizing installed system pressure sources (e.g. pumps, compressors, flasks) may result in test accomplishment much later during the availability than would occur if external pressure sources (e.g. yard air, pumps and equipment) were used to perform a hydrostatic test. As such, the accomplishing activity should be aware that use of this alternative may result in late identification of leaks, late system restoration (lagging installation, etc.), and late occurring water or fluid damage to installed equipment or furnishings. The accomplishing activity shall implement the most cost effective test program for purposes of early detection of leaks in worked joints and the repairs of these leaky joints to avoid adverse cost and schedule impacts from use of this alternative. Performance of a low pressure ″grooming″ test may prove advantageous when this option is chosen. On extensive alterations or renewals of piping, activity should perform a cost benefit analysis to determine if this is the most cost effective option to do.**
2. **It may be cost effective to use spray protection measures such as clear plastic bags around new or repaired joints, or spray shields near equipment that may be damaged or create a safety hazard by a leaky joint. Use of temporary shore services for test fluid, such as firemain, shore steam and low pressure air, may also be cost effective to find leaks earlier in the schedule. A sign off of these items being completed may reduce the damage risk still further.**

3. **To maintain fit up inspection compliance on braze joints, a quality control method should be established to provide brazer accountability to the subject joints until satisfactory completion of tightness testing at nominal operating pressure.**

505-11.1.2.7 Shop Testing of Replacement Piping, Components and Fittings

a. For other than reduced energy criteria systems (those operating at 200 psig or less and 200ºF or less) replaced piping, components, and fittings which were not previously hydrostatically tested by the vendor at the manufacturing plant, in a test lab, or later scheduled to be hydrostatically tested onboard ship (or construction site) to 135%, or whose strength characteristics have been affected (modified) by machining or welding, shall be shop hydrostatically tested to at least 135% of system design pressure, except as follows:
   (1) The item was received from a Navy Supply System Activity with Special Material Identification Code (SMIC) ″SS″, ″L1″,“X1”, “X2”, “X3”, “X4”, “X5”, or”X6”.
   (2) The item was originally procured as Level 1 and certified by an authorized activity in accordance with NAVSEA 0948-LP-045-7010, Material Control Standard.
b. Replacement of valve stems and fasteners, and installation of approved (per NSTM 505 paragraph 505-6.8.1.1) mechanically attached fittings (MAFs) does not require shop hydrostatic testing.

505-11.1.3 HYDROSTATIC TESTING REQUIREMENTS AND PRECAUTIONS. The following general requirements and precautions for hydrostatic testing also apply for testing systems at normal operating conditions when a jumper or temporary test rig is used to pressurize the system. Generally, the sequence for testing is:

a. Establish required prerequisites and initial conditions.
b. Align the system for testing.
c. Pressurize the system slowly and incrementally.
d. Check for leaks at normal operating pressure and two lower incremental pressures.
e. Continue to increase pressure to hydrostatic test pressure.
f. Perform required inspections (see paragraph 505-11.1.3.22).
g. Depressurize, remove temporary equipment, and restore the system to the conditions required for subsequent evolutions.

505-11.1.3.1 Test Termination. Take immediate action to terminate the test and correct the problem if any of the following events occur:

1. Pressure gauges fail to respond to changes in test pressure or gauge rupture during test.
2. Pressure gauge readings do not agree within their required accuracies at any test pressure. Allow for difference in gauge elevations.
3. Test pressure cannot be held constant.

505-11.1.3.2 Pressure Gauges for Hydrostatic Tests. Use two pressure gauges when performing hydrostatic tests. Use a master test gauge having a scale range greater than the maximum test pressure, but not exceeding 200 percent of maximum test pressure (refer to NSTM Chapter 504, **Pressure, Temperature, and Other Mechanical and Electromechanical Measuring Instruments** , for selecting the master test gauge range, graduations, and accuracies) and a system gauge or temporarily installed gauge (with valid calibration date) as a backup gauge. Ensure that other installed pressure instruments and gauges exposed to pressure will not be overranged and damaged by test pressure. There shall be no check valves or closed valves between the gauges and/or relief valves and the system or portion of the system being hydrostatically tested that would render system test pressure indication or overpressure protection inoperative or isolate portions of the system being tested from full test pressure.

505-11.1.3.3 Test Accuracy Verification. Master test gauges and backup gauges shall have a valid calibration label according to NAVSEA OD 54845, **Metrology Requirements List** . Just before starting the test, crosscheck the backup gauge to the master test gauge, up to maximum test pressure, except as follows. For shop test facilities (i.e., Intermediate Maintenance Activities, naval shipyards and tenders) where hydrostatic tests are conducted at least once every two weeks and where the test gauges (backup and master) are covered under the Navy Metcal system, crosschecking the gauges before each test is not required. Also as an alternative, the crosschecks may be accomplished during the actual pressurization of the system for the test. In that case, the crosschecks shall be satisfactorily completed prior to exceeding normal operating pressure. Use the master test gauge readings as the true pressures throughout the tests.

505-11.1.3.4 Overpressure Protection. Manual relief of pressure from the section of the system being hydrostatically tested is the primary method of preventing overpressurization. At least one manually actuated valve shall be provided for overpressure protection during all hydrostatic tests. At least one relief valve shall also be provided as automatic overpressure protection. Provision shall be made to relieve pressure trapped downstream of installed system check valves upon completion of hydrostatic testing. Danger-tag OPEN all valves from the pressure source to the manual overpressure protection valve and to temporary relief valves.

505-11.1.3.4.1 The master and backup test gauges shall be clearly visible and readable by personnel stationed to protect against overpressure. Personnel shall be stationed at the manually actuated overpressure relief valve solely to provide overpressure protection. Provide a red hand or other suitable mark on the face of the pressure gauge at the pressure by which action is required to prevent overpressurization (this may be considered as the pressure half way between maximum hydrostatic test pressure and the backup overpressure protection relief valve setpoint pressure). Personnel controlling the hydrostatic test pressure are not considered a source of overpressure protection. EXCEPTION - When pressure is being applied by a hand-operated test pump or when the primary and backup test gages and the manual overpressure relief valve are all installed on the hydrostatic test rig, the test pump operator may also serve as the primary overpressure protection watch provided: (1) the manual overpressure relief valve is within easy reach, (2) properly set and tested backup relief valve protection is provided (for other than hand operated test pumps, either an audible overpressure alarm is provided or a second backup relief valve is installed on the test rig), and (3) the use of this exception does not result in one individual being solely responsible for satisfactory test performance. For tests of a component or small piping assembly, in a shop test facility as defined in paragraph 505-11.3.3, this exception may be applied even if it results in one operator performing the test.

505-11.1.3.4.2 Backup hydrostatic test overpressure protection may be provided by temporarily installed, self-actuated relief valves or by installed, system relief valves specifically designed to be reset. The relieving capacity, at test pressure of relief valves used for overpressure protection and their inlet and discharge piping, shall be greater than the capacity of the source being used to pressurize the system. The overcapacity should not cause excessive thermal and pressure shock, and the blowdown characteristics of the relief valve shall be compatible with the system being tested. Accumulation shall be 10 percent or less of required test pressure. Accumulation is defined as the increase in pressure above set pressure at which the valve is passing full flow. Do not use temporary relief valves that have a rapid adjustment feature by which the setpoint may be accidentally changed.

505-11.1.3.4.3 Install temporary relief valves so as not to damage the system. The connection to the piping shall be sized to pass the capacity of the pressure source with minimum pressure drop. Tagging shall be in accordance with NAVSEAS0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL** . Discharge temporary relief valves into areas where the discharge will not damage equipment or create personnel hazards.

505-11.1.3.4.4 The setpoints of the temporary relief valve shall be checked in accordance with planned maintenance procedures or semi-annually before being used for the hydrostatic test. When conducting a 135-percent test, the setpoint of the relief valve shall be no greater than 100 lb/in. ^{2} above the test pressure or 10 percent above the test pressure, whichever is less.

505-11.1.3.5 Briefings and Communications. Before conducting the hydrostatic test, instruct participating personnel in the test plan and emergency actions. Station personnel in convenient locations for reading the master test pressure and backup gauges and for operating valves that control pressure to the system or portions of the system being tested. These personnel shall be in communication with the test manager throughout the test.

505-11.1.3.6 Plant and System Status. Establish plant conditions required to safely perform the hydrostatic test without danger to personnel or damage to equipment. This may require shutdown of the complete system, or it may require only the isolation of a component or portion of the system. Systems to be tested shall be completely filled and vented. Portions of systems not being tested shall be vented. Have a sufficient quantity of water of appropriate quality available to complete the test. Station personnel in accordance with paragraph 505-11.1.3.5.

505-11.1.3.7 Test Fluid. Use clean, fresh water for all piping system hydrostatic tests except as specifically identified below. Do not use water that will degrade the system's cleanliness or purity of the operating fluid in the system. Maximum effort should be made to utilize feed grade water when testing steam or feedwater systems. Use of potable water can contaminate steam or feedwater systems with chlorine, bromine, and other mineral products. Use seawater only in tests of contaminated oil, ballast, or seawater systems. If seawater is used, be sure it is clean.

505-11.1.3.8 Oil Systems. System fluid shall be the test fluid for hydraulic and lubricating oil systems. Testing of hydraulic system piping with water and other flushing fluids is permissible when accomplished in accordance with MIL-STD-419, **Cleaning and Protecting Piping for Hydraulic Power Transmission Equipment** .

a. Apply test pressure slowly and incrementally.

b. Do not perform hot work; secure other sources of ignition, and post a fire watch in spaces containing hydraulic or lubricating oil piping subject to test pressure.

505-11.1.3.9 Oxygen and Nitrogen Gas Systems. Refer to MIL-STD-1330, **Cleaning and Testing of Shipboard Oxygen, Nitrogen and Hydrogen Gas Piping System** , for testing of shipboard oxygen and nitrogen gas systems.

505-11.1.3.10 Compressed Air System. When water is used to test a service air system, thoroughly purge or dry the affected system or system portion before returning it to service. Remove valves that may be damaged by exposure to water and jump or blank the piping. Refer to NSTM Chapter 551.

505-11.1.3.11 Compressible Fluids. Safety considerations for testing with compressible fluids of paragraph 505-1.4.2 (Leak Inspections) and MIL-STD-1330 shall be followed for the following reasons:

1. Rupture of a system tested with a highly compressed fluid (gas) will be significantly more violent than the rupture of a system tested with a relatively non-compressible fluid (liquid) such as water or oil. This is due to the volume of the test medium which must escape before the pressure differential reaches zero.

2. Small leaks are difficult to detect.

505-11.1.3.11.1 The risk of large energy release because of a compressed gas volume applies, although to a lesser extent, if a system is not properly vented before a hydrostatic test. Therefore, eliminate air pockets before pressurizing any system for a hydrostatic test.

505-11.1.3.12 Test Fluid Temperature. The temperature of the test fluid shall be between 40 degrees F and ambient not to exceed 120 degrees F to minimize risk to material and to personnel performing the tests.

505-11.1.3.13 Isolation. If the portion of the system that requires testing can be isolated from the remainder of the system by valves or other means capable of withstanding the test pressure, perform the test only on this isolated portion. In particular, avoid pressurization of heat exchangers if not required for the hydrostatic test. Isolation shall prevent leakage into adjacent systems that might inadvertently pressurize portions not requiring a test. Portions of systems which could be inadvertently pressurized as a result of isolation valve leakage shall either be vented or contain relief valve protection to prevent overpressurization due to isolation valve leakage.

505-11.1.3.14 Equipment Protection. Protect equipment, tanks, and machinery that would be subjected to a test pressure higher than their specified test pressure, by disconnection from the system or isolation from the test. When a shipboard hydrostatic test is required for such equipment or machinery at a lower test pressure than the system hydrostatic test pressure, the piping attached to the equipment or machinery up to the first cutout valve may be tested with the equipment or machinery rather than at system test pressure. Protect equipment or machinery that may be damaged or adversely affected, or whose operation may be impaired by the test liquid, by disconnection from the system or isolation from the test.

505-11.1.3.15 Protection by Blanks. Blanks (blind flanges) used for isolation shall be fabricated of a suitable metal and thickness. Blanks shall be constructed with a permanent tab for tagging. Reference tags (S0400-AD-URM-010/TUM, **TAG-OUT USERS MANUAL**) attached to the tab shall have a notation that a blank has been inserted for hydrostatic tests and that it shall be removed before operational testing. Keep a written record of all gags and blanks installed for tests and prepare a signed checkoff list to verify they have been removed after test completion.

505-11.1.3.16 Air Coolers and Lube Oil Coolers. Minimize hydrostatic testing of air coolers and lube oil coolers. Whenever practical, isolate the cooler from the system being hydrostatically tested, unless testing of the cooler is required due to repairs to the cooler itself. Whenever a cooler is hydrostatically tested, take the following special precautions to protect components and systems since it may not be possible to visually detect leakage:

a. Whenever an air cooler is hydrostatically tested, the following requirements apply:

   1. Place a collection container below each air cooler void space drain (for example, the drain between the air cooler's inner and outer tubesheet) and inspect the void space drain for leakage. If leakage is observed, correct the cause before proceeding with the hydrostatic test.

2. Perform the following actions whenever the mechanical joint between the waterbox outer tubesheet is located such that leakage from this joint could enter the machine (for example, the turbine generator that the air cooler serves):
   (a) Remove any drain plugs or cleanout covers in the bottom of the machine which the air cooler serves and place a collection container below the drain openings or cover openings. If leakage is observed, correct the cause before proceeding with the hydrostatic test or before energizing the machine.
   (b) Inspect the mechanical joint between the waterbox and outer tubesheet for leakage. Remove any covers required to perform this inspection. If leakage is observed correct the cause of the leakage before proceeding with the hydrostatic test or before energizing the machine.

b. Whenever an oil cooler is hydrostatically tested, the following requirements apply:
   1. Drain all oil from the cooler before testing. Keep oil side drains open.
   2. If water leakage into the oil side of the cooler can still enter the lube oil system (by not draining through the oil side drains), blank off the lube oil cooler oil inlet and outlet, if possible. Otherwise, drain the lube oil system and open low point drains in the lube oil system.
   3. Place dry collection containers below the open oil drains.
   4. If water collects in the collection container during the hydrostatic test, is found in the lube oil cooler when the blanks are removed, or is found in the drained sump, correct the cause and repeat the cooler test.

c. If the above requirements cannot be met while the cooler is installed in the system or equipment it serves, remove the cooler for a shop hydrostatic test.

505-11.1.3.17 Steps Before Pressurizing. Perform the following steps before pressurizing:

a. Provide any expansion joints with temporary restraints, if required to resist the additional test pressure load, or isolate them from the test.

b. If temporary hoses are used either in test rigs or as jumpers within the system being tested, verify that the hoses are adequate for the test pressure and fluid. A tabulation of approved hoses and fittings is given in NAVSEA Technical Directive S6430-AE-TED-010, Volume 1.

c. Eliminate air pockets before any system is pressurized for a hydrostatic test. The sudden release of compressed gas can injure personnel and damage equipment.

WARNING

Failure to verify the correct position of valves to be pressurized may cause injury to personnel and damage to components.

d. Verify that all valves and equipment in or connected to the portion of the piping system to be pressurized are in the required position or condition. Do not admit steam or hot water into an open occupied boiler, nor open circulating water valves to an open condenser.

505-11.1.3.18 Pressurizing to Test Pressure. During hydrostatic testing of systems with a maximum system pressure in excess of 300 lb/in.^{2}, raise test pressure in increments of approximately 25 percent from 0 to 100 percent of the final test pressure. When changing pressure during hydrostatic testing of piping systems that include a component subject to brittle fracture (e.g., steam receivers, wet accumulators, boilers, and possibly some heat exchangers), limit the rate of pressurization and depressurization to 100 psi per minute to ensure that pressure stresses are applied or relieved uniformly. For all other systems, limit pressurization and depressurization rates as necessary to maintain controllability. At each increment, check for leaks before proceeding to the next higher pressure increment. Tolerance for hydrostatic test pressure variation shall be +2 to -0 percent of the nominal hydrostatic test pressure, rounded off to the nearest multiple of the smallest graduation of the test pressure gauge, not to exceed 50 lb/in. ^{2} . For test pressures less than 100 lb/in. ^{2} , a tolerance of +1 to -0 lb/in. ^{2} tolerance is required.

505-11.1.3.19 Visual Inspections. Visual inspections are required at specified intervals as the pressure is increased to the test conditions. Repaired areas that are being tested shall remain uninsulated to allow examination for leakage.

505-11.1.3.20 Test Duration. Maintain the test pressure for at least 30 minutes before inspection to permit accumulation of moisture. Maintain the test pressure throughout the inspection period.

505-11.1.3.21 Test Completion and System Restoration. After test completion, depressurize the system slowly to allow stresses to be equalized. Do not exceed the depressurization rate specified in paragraph 505-11.1.3.18. Remove all hydrostatic test equipment including gags, blanks, and jumpers.

505-11.1.3.22 Acceptance Criteria. The criterion for an acceptable hydrostatic test is there shall be no leakage or permanent deformation of pressure-containing parts, as determined by visual examination, except as noted in paragraph 505-11.1.3.22.1 through 505-11.1.3.22.5. Do not consider the test complete until all specified inspection points have been recorded as satisfactory and test pressure has been maintained for the specified time period. If a leak, other than at a mechanical joint, is discovered and repaired, subject the system or affected portion of the system to the same hydrostatic test. Exceptions to the no leakage criterion for an acceptable hydrostatic test, listed in paragraph 505-11.1.3.22.1 through 505-11.1.3.22.5, may be applied providing that:

a. The leakage does not become hazardous to personnel.

b. The leakage can be adequately contained to protect equipment.

c. The leakage is within the capacity of the hydrostatic test pump to maintain pressure throughout the test.

505-11.1.3.22.1 Mechanical Joint Leakage. Mechanical joint leakage at hydrostatic test pressure shall not render the test results unsatisfactory. Mechanical joints which leak at hydrostatic test pressure shall be reinspected at the nominal operating pressure. Mechanical joints that leak at hydrostatic test pressure should be checked for proper makeup and fastener tightness, even if the leakage stops when pressure is reduced to normal. Leakage at nominal operating pressure is not permitted; repair as necessary. Repairs shall not be accomplished while the system is pressurized. Reinspect the joint for leakage at nominal operating pressure after repair. With the exception of mechanical joints in steam, compressed air, and compressed gas systems, mechanical joints which do not leak at hydrostatic pressure do not require tightness testing at operational pressure. New or disturbed mechanical joints in steam, compressed air, and compressed gas systems shall be inspected for tightness using system fluid at nominal operating pressure and temperature.

505-11.1.3.22.2 Valve Seat Leakage. Leakage across boundary valve seats shall not render the test results unsatisfactory; however, valves shall be repaired if the applicable leakage rate is exceeded. See section 505-11.3.6 for acceptable valve seat leakage rates.

505-11.1.3.22.3 Valve Packing Leakage. Valve packing leakage at hydrostatic test pressure shall not render the test results unsatisfactory. If valve packing leakage in excess of that allowed in the component technical manual occurs during a hydrostatic test while at or below nominal operating pressures, correct it as soon as possible. Packing that has been depressurized for an extended period of time may become dry and shrink. Allow a waiting period of 5 to 10 minutes after pressurization for the packing to stabilize before ascertaining leakage. Leakage shall be determined at nominal operating pressure. The observation of water or dampness at the fluid boundary formed by stem packing does not necessarily constitute unacceptable leakage. Unless specified otherwise in an applicable component technical manual, acceptable leakage rates are as follows: For water or other liquids, the fluid shall not form drops that enlarge enough to drop or flow away from the formation point in 5 minutes. For steam valves, hold a small mirror about two inches from the packing gland. One drop running down the face of the mirror within two minutes is unacceptable leakage. Only newly installed valves and valves suspected of having packing leakage need to be inspected during the hydrostatic test. If valve packing leaks are detected, adjust the packing according to the component technical manual or replace the packing, then inspect for leakage with the system at normal operating pressure. When valve packing inspections are to be conducted in conjunction with a hydrostatic test, begin the test with all open valves to be inspected off their backseat. Increase test pressure to nominal operating pressure and inspect for packing leakage. After inspecting for leakage, backseat (if applicable) all valves that are required to be open, and continue the hydrostatic testing. Where throttle valves have been positioned in a system to maintain set flow conditions, do not backseat these valves.

505-11.1.3.22.4 Pump Gland, Pump Packing, and Pump Mechanical Seal Leakage. Pump gland, pump packing, and pump mechanical seal leakage at hydrostatic test pressure shall not render the results unsatisfactory. If leakage is in excess of that allowed in the component technical manual and occurs during a hydrostatic test while at or below normal operating pressures, correct it as soon as possible.

505-11.1.3.22.5 Leakage at Temporary Mechanical Connections for the Hydrostatic Test. Leakage at temporarily capped, blanked, plugged, or jumper connections or at test fittings, shall not render a hydrostatic test unsatisfactory provided the leakage rate is less than the capacity of the hydrostatic test pump at the test pressure.

505-11.2 SHOP TESTING OF PIPING SUBASSEMBLIES.

When major modifications are accomplished by shop fabrication of piping subassemblies, consideration should be given to testing these subassemblies in the shop prior to shipboard installation. Such shop testing may avoid the need for shipboard hydrostatic testing, may provide assurance of proper work accomplishment and minimize subsequent delays associated with rework after shipboard testing, may facilitate inspections which could be difficult to perform shipboard, etc. Unless otherwise specified, shop tests for strength and porosity of components and piping system subassemblies shall be maintained for 5 minutes minimum before inspection.

505-11.3 SHELL HYDROSTATIC AND SEAT TIGHTNESS TESTING OF VALVES

505-11.3.1 GENERAL. The following criteria is applicable to globe, angle, gate, check, ball, poppet, and butterfly valves.

505-11.3.2 LEVEL OF REPAIR. Valve repairs are classified as described in the following paragraphs.

505-11.3.2.1 Minor Repair. Minor repairs are operations that could be considered maintenance such as replacing packing and pressure seal ring, lubricating, lapping or grinding of seats, and replacing damaged parts such as stems and discs.

505-11.3.2.2 Major Repair. Major repairs are operations that structurally affect the pressure-containing portion of the valve through welding, brazing, or other fabrication process. Major repairs also include the replacement of pressure boundary parts (other than valve stems, discs, or fasteners) with parts, which previously have not been hydrostatically tested.

505-11.3.3 SHOP-REPAIRED VALVES. Valves can be shop repaired in two types of facilities:

1. Naval shipyards, tenders, and naval repair facilities
2. Commercial valve repair shops.

505-11.3.4 TESTING. Test repaired valves as described in the following paragraphs.

505-11.3.4.1 Shop-Repaired Valves. Subject shop-repaired valves which have undergone major repairs to the same tests as a new valve; however if the exact end use is known, it may be hydrostatically tested to the required system hydrostatic test pressure. For submarines, refer to the applicable ″Test Pressure Drawing″ (TPD). Verify testing has been completed before installing the valve. Testing and seat leakage requirements can be found in the applicable maintenance standard, valve technical manual, drawings or specifications. If testing cannot be verified, subject the valve to shell hydrostatic and seat tightness tests at the applicable pressures specified in table 505-11-1. Shop-repaired valves that have undergone minor repairs which affect valve seat tightness capability, such as seat lapping or grinding, and replacement of seats and discs, should be subjected to a seat tightness test. Hydrostatic testing of the valve is not necessary after minor repairs.

505-11.3.4.2 Shipboard-Repaired Valves. Subject shipboard-repaired valves, which have undergone repairs which affect the valve seat such as lapping or grinding of seats, and replacement of seats and discs, to a seat tightness test at the applicable system operating pressure.

505-11.3.5 TEST PROCEDURES. All tests shall be performed in accordance with the following procedures, unless otherwise specified:

a. Perform shell hydrostatic and seat tightness tests at the pressure specified in the applicable test pressure drawing, system diagram, component technical manual, ship valve technical manual, maintenance standard, or, if none of these are available, in accordance with table 505-11-1. Clean water or the system liquid may be used as the testing medium, provided that the fluid temperature does not exceed 120°F.

Table 505-11-1. GATE, GLOBE, AND CHECK VALVE TEST [Note 1] PRESSURES (Sheet 1 of 2 Steel Valves)

Steel Valves [Note 2]			
ANSI Class	**100°F Pressure Rating lb/in. ^{2}**	**Hydrostatic Shell Test Pressure lb/in. ^{2}**	**Hydrostatic Seat Test Pressure lb/in. ^{2}**
150	290	450	325
300	750	1,125	825
400	1000	1,500	1,100
600	1500	2,250	1,650
900	2250	3,375	2,475
1500	3750	5,625	4,125
2500	6250	9,375	6,875

Table 505-11-1. GATE, GLOBE, AND CHECK VALVE TEST Note 1

PRESSURES (Sheet 1 of 2 Steel Valves) - Continued

Steel Valves Note 2			
ANSI Class	**100°F Pressure Rating lb/in. 2**	**Hydrostatic Shell Test Pressure lb/in. 2**	**Hydrostatic Seat Test Pressure lb/in. 2**
4500	11250	16,875	12,375
Nonferrous Valves			
Pressure Rating-Cold Water Oil or Gas lb/in. 2		Hydrostatic Shell Test lb/in. 2	Hydrostatic Seat Test lb/in. 2
40		60	40
100		150	100
150		225	150
200		300	200
225		338	225
250		375	250
300		450	300
400		600	400
500		750	500
600		900	600
700		1050	700
3000		4500	3000

Notes:
1. See paragraph 505-11.3.4.1 before using this table.
2. Data on steel valves is taken from ANSI B16.34-1988.

Table 505-11-1. GATE, GLOBE, AND CHECK VALVE TEST Note 1
PRESSURES (Sheet 2 of 2 Nonferrous Valves)

Nonferrous Valves		
Pressure Rating-Cold Water Oil or Gas lb/in. 2	**Hydrostatic Shell Test lb/in. 2**	**Hydrostatic Seat Test lb/in. 2**
40	60	40
100	150	100
150	225	150
200	300	200
225	338	225
250	375	250
300	450	300
400	600	400
500	750	500
600	900	600
700	1050	700
3000	4500	3000

Note:
1. See paragraph 505-11.3.4.1 before using this table.

b. Apply the maximum handwheel force to seat gate and globe valves for seat tightness testing in accordance with table 505-11-2.

c. Where practicable, conduct tests so that seat leakage can be measured.

d. Apply test pressure in the direction tending to open the valve. For gate valves and ball valves, apply the pressure alternately on both sides of the disc or ball with the opposite end open for inspection. Seat tightness tests in the shop shall be performed in both directions. Test unidirectional gate valves or ball valves only in the direction of flow. Where the inboard side of a valve is open to atmosphere or never pressurized during normal system operation (i.e. escape trunk flood and drain valves, weapons shipping hatch drain valves, etc.), the seat tightness tests shall be conducted from the pressurized side only, provided the end use application of the valve is known, controlled and does not change. Shipboard seat tightness tests shall be performed in the direction of flow. Test duration shall be 3 minutes for shop tests and 3 minutes for shipboard tests.

e. If there is any visible leakage, continue the test for a sufficient length of time to accurately determine the leakage rate.

f. Inspect valves for external leakage. No leakage is permitted.

Table 505-11-2. VALVE HANDWHEEL FORCES

Handwheel Diameter (inches)	Maximum Tangential Force on Rim of Handwheel (Pounds)	Maximum Equivalent Torque atCenter of Stem (lb-ft)
2 or less	90	7.5
3	98	12
4	106	18
5	112	23
6	118	29
7	121	35
8	124	41
9	127	48
10	130	54
11	133	61
12	135	68
14	138	81
16	141	94
18	144	108
21	147	129
24	150	150
27	150	169
30	150	188
36	150	225

505-11.3.6 SEAT TIGHTNESS ACCEPTANCE CRITERIA. Unless otherwise specified in the applicable maintenance standard, valve technical manual, drawing, specification, or ordering data; seat leakage shall be as specified in the following paragraphs.

505-11.3.6.1 Metal-to-metal Seated Valves. New or refurbished valves having metal-to-metal seats shall not leak more than 10 ml/hr/in. of nominal pipe size (NPS) diameter. The maximum leakage rate for new or refurbished valve sizes less than 1-1/2 inches is 10 ml/hr.

505-11.3.6.2 Soft-seated Valves. New or refurbished soft-seated valves, other than check valves, shall not leak. Visible signs of leakage shall be cause for rejection.

505-11.3.6.3 Check Valves. Test check valves for leakage by applying back pressure according to table 505-11-4. Leakage rates for new or refurbished check valves shall not exceed those given in table 505-11-3.

505-11.3.6.4 Stop-check Valves. Test stop-check valves with the valve in the open position. The back-pressure applied shall be according to table 505-11-4 Leakage rates for new or refurbished stop-check valves shall not exceed those given in table 505-11-3.

Table 505-11-3. CHECK VALVE LEAKAGE RATES

Valve Size (Nom)	Leakage Rate
Under 1-1/2 inches	10 ml/hr
1-1/2 to 2 inches inclusive	25 ml/hr/in dia
2-1/2 to 10 inches inclusive	50 ml/hr/in dia
Over 10 inches	100 ml/hr/in dia

505-11.3.6.5 Shipboard Test Procedures All shipboard tests shall be subject to the following procedure:

a. Examine valves for external leakage. No leakage is permitted.

b. Where practical, observe possible seat leakage. In many cases, it is not practical to measure seat leakage and it may be very difficult to determine the actual source of apparent leakage. In these cases, one of the following may be substituted: For non-ball valves, a satisfactory blue check of seat and disc contact (100% seat contact required) areas constitutes the acceptance criterion. For ball valves, a dimensional verification/stack height check to verify adequate seat compression may be used. The 100 percent blue check or stack height/cavity width option for non-nuclear and non-Subsafe submarine piping systems is approved for repaired in place flanged valves when the joints were not disassembled.

Table 505-11-4. BACK-PRESSURE RATES

Valve Ambient Temperature Pressure Rating	Test Back-Pressure
150 lb/in.^{2} and below	50 lb/in.^{2}
Over 150 lb/in.^{2}	100 lb/in.^{2}

505-11.3.6.6 Seat leakage rates for in-service submarine sea water valves. Seat leakage rates for in-service valves when tested against surface hydrostatic head may exceed the values listed for repaired valves. Permissible leakage rates for in-service valves should be based on the effect of the leakage on the integrity, operation, safety, and function of the valve and associated systems and the opportunity for valve repair based on the ship's availability schedule. For submarines, additional guidance can be found in the maintenance section of the applicable ship Steam and Electric Plant Manual. The local Performance Monitoring Team should also be contacted for additional guidance, if necessary.

505-11.3.6.7 Seat leakage rates for in-service surface ship valves. Seat leakage rates for in-service valves (not repaired) may exceed the values listed in paragraph 505-11.3.6.1 through 505-11.3.6.5. Permissible leakage rates for in-service valves should be based on the valves ability to perform its intended function. For example, a steam root valve to a turbine may exceed the newly repaired leakage rate. The leakage may be acceptable if it does not cause the turbine to roll over. Leakage of a main seawater circulating system valve may be acceptable if it does not exceed the capacity of the condenser waterbox drain. However, high leak rates may cause accelerated valve seat and disc damage due to high velocity flows across the seating surface of shut valves. In order to minimize this damage, it is recommended that metal-to-metal seated valves be repaired when leakage exceeds 100 mL/hr/

in. of nominal valve size. This criteria may also be applied to soft seated valves. The ships Engineering Officer or his designated representative shall determine if the leakage rate is acceptable where specific NAVSEA guidance is not provided.

505-11.4 PERIODIC OPERATIONAL TESTS.

Where operationally practicable, operational piping systems shall be tested at the system's operating pressure using the service fluid. Conduct this test by pressurizing the system, one section at a time, to detect leaking valves and to ensure proper operation of all system valves. Requirements for halocarbon refrigeration systems are contained in NSTM Chapter 516.

SECTION 12

REMOTE OPERATING GEAR (ROG) SYSTEMS

505-12.1 GENERAL.

Remote operating systems are provided on valves, which have to be operated remotely during damage control situations, casualty, and where the accessibility of the valve is restricted. This section is devoted to discussion of manually operated ROG systems. In the past, the navy has experienced many problems with manual ROG systems. Problems generally occurring are due to improper installation, improper selection (misapplication), degradation of ROG components, loss of alignment, and degradation of the valves being actuated. Some of these problems involve the use of the ″STOW″ type rotary flexible shaft ROG. The primary problems with this system stem from excessive deflections or ″wind up″ caused by the core's torsional limitations. Because of this, a limitation of eight feet per installation was imposed in new ship specifications. Another problem with this system is the fact that the system is made of ferrous material resulting in excessive corrosion. Because of the problems with this particular system it has been restricted from being used on all new ship construction. Whenever, existing ″STOW″ type systems require repair or replacement, it is acceptable to do so as long as the replacement parts are upgraded with corrosion resistant materials, the core/casing have equal or greater torsional capabilities, and assurance is made that the original system was operable.

There are basically three different types of remote valve operation that are performed by using ROG's, classified as follows:

(a) **Trip mechanisms-such as a fuel quick closing valve**

(b) **Open/shut situations-such as completely opening or closing a valve for damage control purposes, and**

(c) **Throttling-Where precise positioning of the valve is needed for flow or pressure control**

At the present time there are six different type Remote Operating Gear (ROG) Systems that are approved for use on US Naval ships:

1. Rigid Rod   This system is generally made from tubular or solid shafting, bearings for support, universal joints, gearboxes and swivel gears for changing direction.
2. Rotary Flexible shaftUniflex (manufacturer B.W.Elliott Mfg. Co. LLC)   This system utilizes a stainless steel flexible shaft that rotates within a conduit to transmit torque to a remote valve. This system can be used for both multi turn and 1/4 turn valves.
3. Dual Linear (manufacturer Triumph Controls Inc. formally Teleflex)   This system utilizes a flexible steel shaft within a conduit that transmits torque by linear motion. This system can be used for multi turn and 1/4 turn valves.
4. Single Linear (manufacturer Triumph Controls Inc. formally Teleflex)   Utilizes linear motion to transmit torque same as duel linear system. This system is used for remote trip mechanisms.
5. Single Linear Ball Bearing (manufacturer AeroControlex Corp)   This system uses linear motion to transmit torque ,however, it utilizes ball bearing to reduce friction. This system is used for 1/4 turn valves.
6. Dual Linear Ball Bearing (manufacturer AeroControlex Corp)   This system utilizes linear motion to transmit torque plus ball bearing for reduced friction. This system is used for multi turn valves. ROG Procurement Specifications-Past practice has been to use the NAVSEA Technical manual to procure ROG's. Although there is an effort ongoing to develop an ASIM Standard Guide (interim designation Z6497Z), it is not planned to use this as a procurement specification. It is planned to continue with using the manufacturer's NAVSEA technical manual together with this write-up to procure ROG systems in the future.

Where valves are accessible, the ROG shall have a quick disconnect, which would disengage the ROG to allow local operation. Inaccessible valves would not require this feature.

505-12.2 Rigid Rod.

This system is generally made from tubular or solid shafting, bearings for support, universal joints, gearboxes and swivel gears for changing direction. Specifications should be in accordance with the following:

Rigid shafting (tubular)	Mil-P-24691/1
Rigid shafting (solid)	SAE AMS QQ-S-763
Universal joints	Mil-U-20625
Deck plates	5000-S4823-860220
Lock boxes	5000-S4823-1385502, or as approved
Hand-wheels	803-1385620
Bulkhead penetrations	S4824-841653

Operating systems shall have reduction gearing or hand-wheels larger than those normally furnished with the valves where necessary for easy operation or more sensitive control. Slip type couplings shall be used on rigid shafting where necessary for system flexibility or valve stem movement. Lengths of shafting between couplings or other detachable components shall be such that it is not necessary to cut the shaft for removal, or necessary that multiple shorter pieces be installed in replacement.

505-12.3 Rotary Flexible Shafting Mechanical Valve Actuator System (Uniflex).

Navy Technical Manual: S6435-SM-MMM-010 identifies the rotary flexible shafting system. System installation instructions, operating procedures, and limitations are described in this manual. Essentially, the approved system manufactured by Elliott Company is their ″UNIFLEX″ system, Figure 505-12.1 and Figure 505-12.2. This system features stainless steel construction of the core and casing. This system comprises an outer casing in which a wire rope cable rotates The deck box or remote operating station induces a stepped up rotary motion to the cable which minimizes the torque on the cable, at the valve station actuator this actuator reduces the rotary motion to the necessary ratio to operate the valve .The overall rotary ratios for the system can vary from: 2:1,3:1,4:1,6:1,9:1 and 15:1. All the components are non corrosive and also can be non-magnetic if desired.

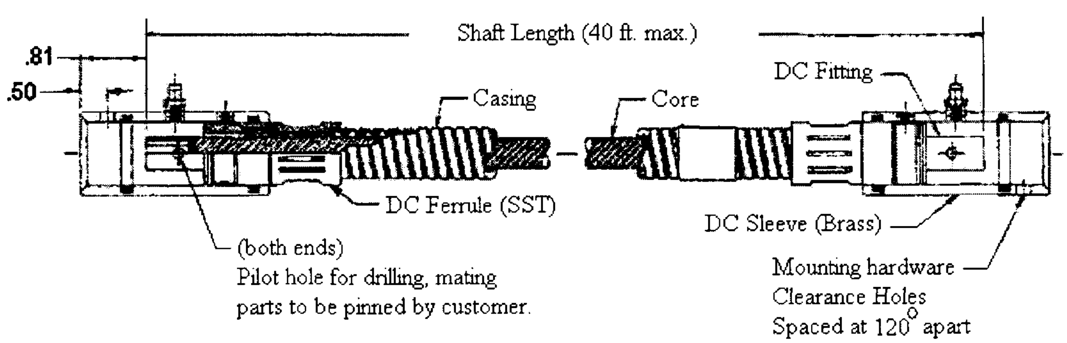


Figure 505-12-1. Typical Flexible Shaft Assembly

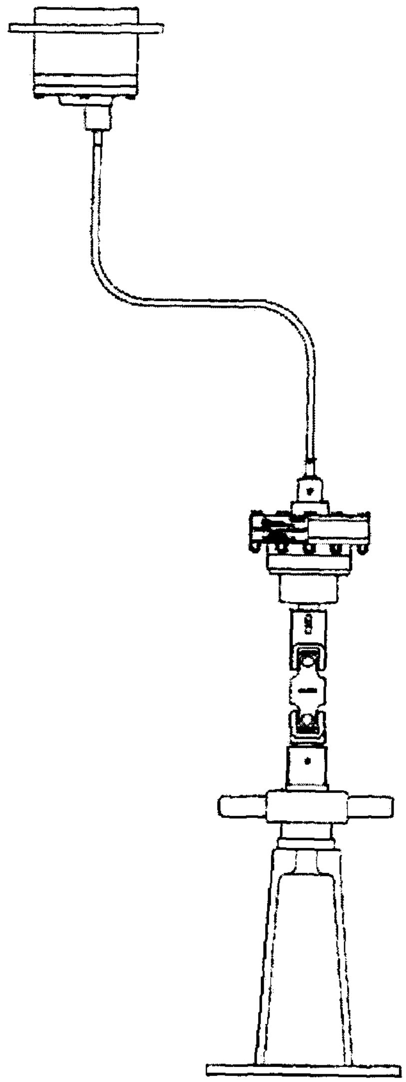


Figure 505-12-2. ROTARY FLEXIBLE SHAFT SYSTEM (UNIFLEX)

505-12.4 Dual and Single Linear Flexible System (Triumph Controls Inc.).

These systems are described by the Navy technical manuals: S6435-QJ-MMI-010 and S6438-AA-DDT-010 respectively. These manuals provide system installation instructions, operating procedures and limitations. This system Figure 505-12.3 employs a helix cable within a conduit. The helix cable slides linearly in one direction or the other (depending if valve is opened or closed) within the conduit. The rotary input motion is converted to linear motion as the helix cable meshes with the spur gears at the remote station. This linear motion is transformed back to rotary motion by a spur gear in which the cable helix fits in the gear teeth at the remote station, which in turn operates the valve.

The dual linear system using two helix cables (one complete circuit) is needed for both quarter turn and multi turn valves. As can be seen in the system sketch Figure 505-12.3 a connector connects the cable. This connector cannot go through the gears on each end of the system. Therefore the linear distance to open and close the valve must assure that the connector never enters into the gears, therefore the cable system or distance from the remote station and the valve itself has to be a minimum distance to avoid the need to have excessive cable. The manufacturer has recently developed a connector link, which can pass through the spur gears thereby eliminating the minimum distance limitation. It should also be noted that in order for the input shaft rotation to correspond to the output shaft rotation that the cable must have a figure eight configuration (not shown in figure below). The duel linear system can be provided with the following gear ratios: 1:1, 2:1, 4:1, 8:1 and 16:1.

The single linear system, is a single cable system with a helix exactly like the duel system described above except the cable is not a continuous cable. This system is described in the NAVSEA technical manual S6438-AA-DDT-010, which describes the system, installation instructions and operating requirements. This actuator is primarily used as a remote trip mechanism for tripping quick closing trip valves.

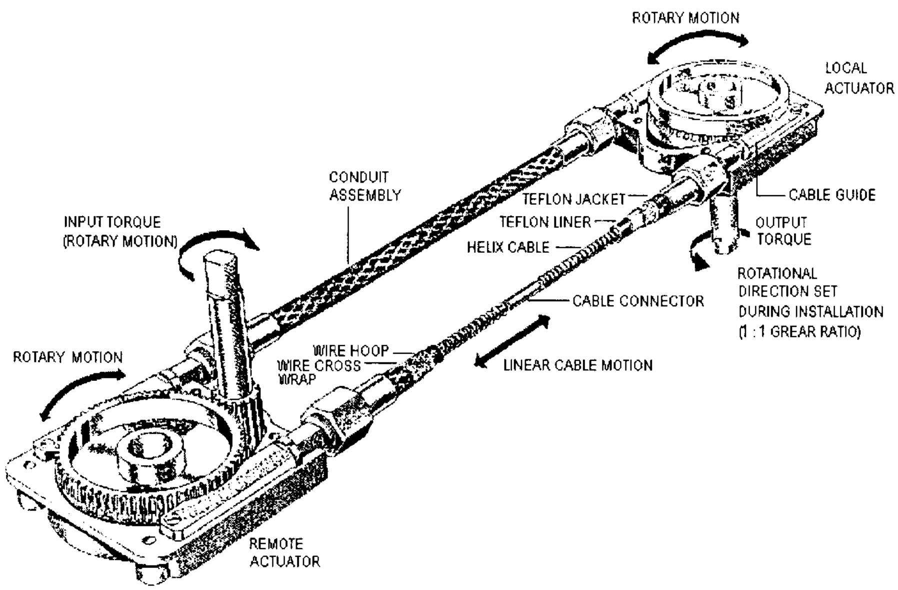


Figure 505-12-3. Dual Linear Flexible System

505-12.5 Multi Turn Dual Linear Ball Bearing System (AeroControlex Group).

Navy technical manual: S6435-GZ-MMA-010 identifies the Multi Turn ball bearing system, Figure 505-12.4. System installation instructions, operating procedures, and limitations are described in this manual. This system transmits force through a reciprocating plate that is captivated by steel ball bearing guides, Figure 505-12-6. An input actuator assembly causes linear reciprocating motion to the plate. Flexible conduit encases the entire plate, bearing guide, and ball bearings. The linear motion is converted back to rotary at the output actuator assembly by the use of a crank mechanism. This system is used for multi turn valves where high torque is required. This system has a high efficiency, is capable of transmitting high torque has very little bask-lash (wind up/lost motion), and provides good ″feel″ and valve control. This system can be provided with 4:1, 2.9:1, 2:1, 1.5:1 and 1.15:1 overall gear ratios.

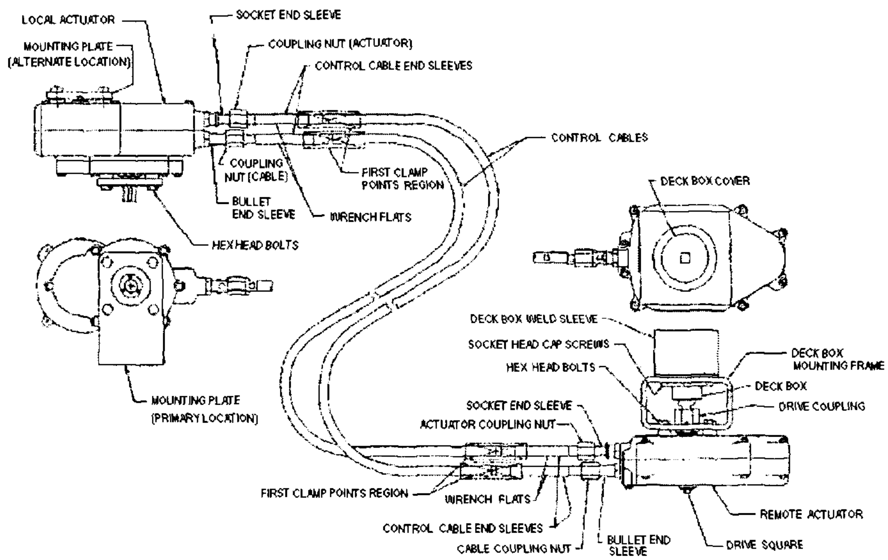


Figure 505-12-4. Multi-Turn Ball Bearing Remote Valve Operating Sys

505-12.5.1 Quarter Turn Single Linear Ball Bearing System AeroControlex Group. Navy technical manual S6435-NS-MMA-010 identifies the Quarter Turn ball bearing system. System installation instructions, operating procedures and limitations are described in this manual. Force transmission elements of this system are similar to the dual linear ball bearing system except only one control cable is used, Figure 505-12.5 and Figure 505-12-7 through Figure 505-12-9. For quarter turn valve operation the linear motion is converted to rotary motion by a rack and pinion arrangement located at the valve actuator. Because of the high efficiency of this system and the low back-lash (wind up/lost motion) this system can be used for high torque applications and wherever valve control is needed. For quarter turn valves, e.g. high performance butterfly valves, the gear box provided by the valve manufacturer can be eliminated where valve torque values are within system limits and facilities are provided for local manual operation plus prevention of the valve back driving the ROG system. This allows the single linear system to be used, which reduces cost with reduced maintenance.

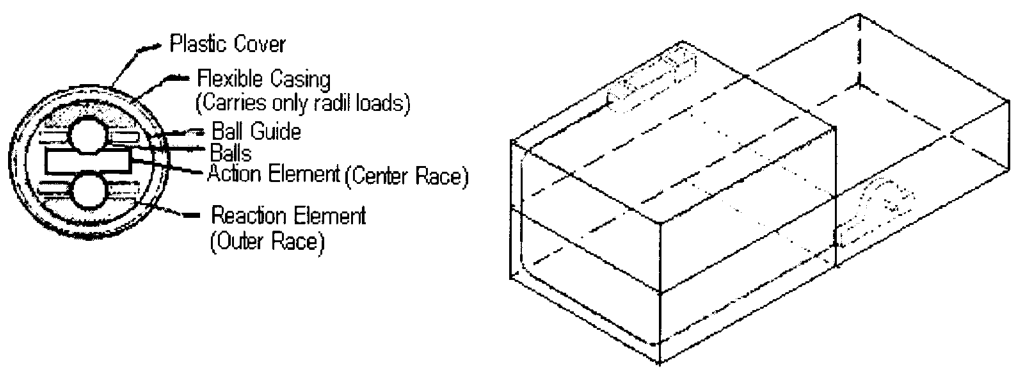


Figure 505-12-5. Typical Cross Section and Installation

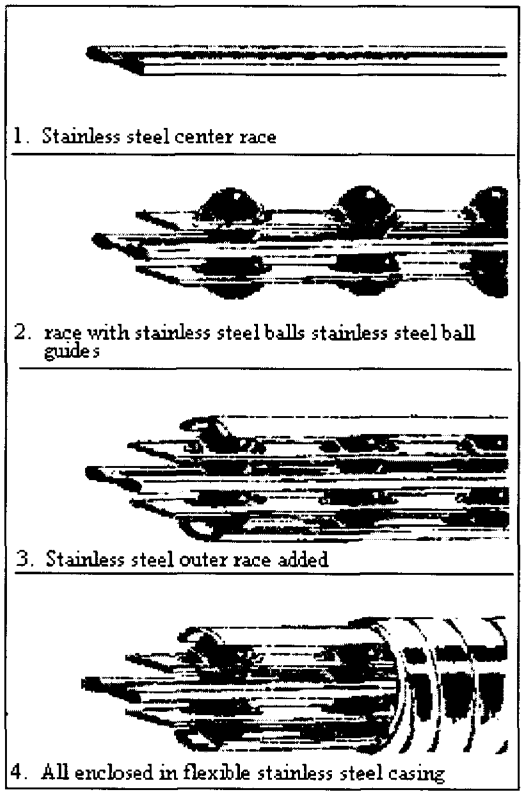


Figure 505-12-6. Linear Bearing System

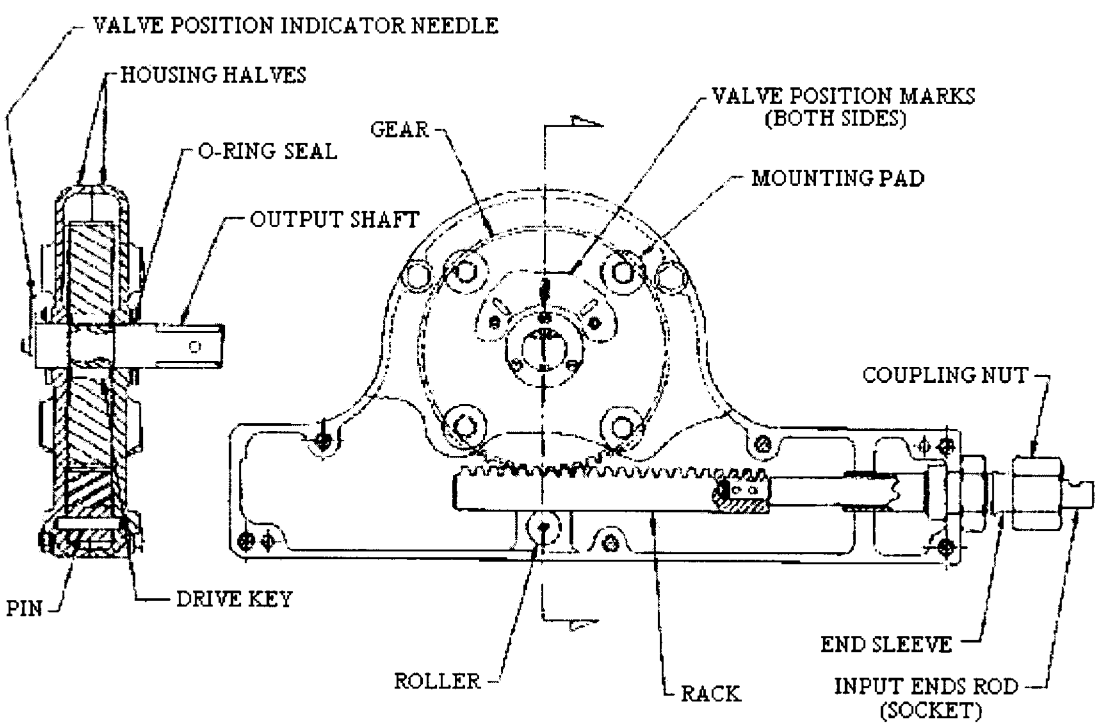


Figure 505-12-7. Single Linear Ball Bearing 1/4 turn system-interface between actuators and ball bearing control

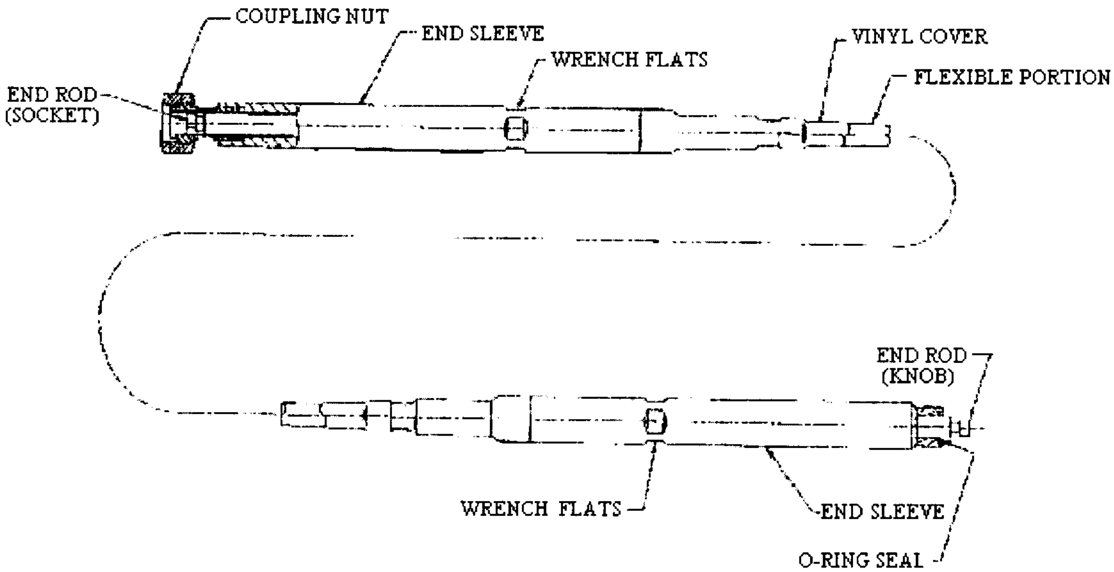


Figure 505-12-8. Single Linear Ball Bearing 1/4 turn system

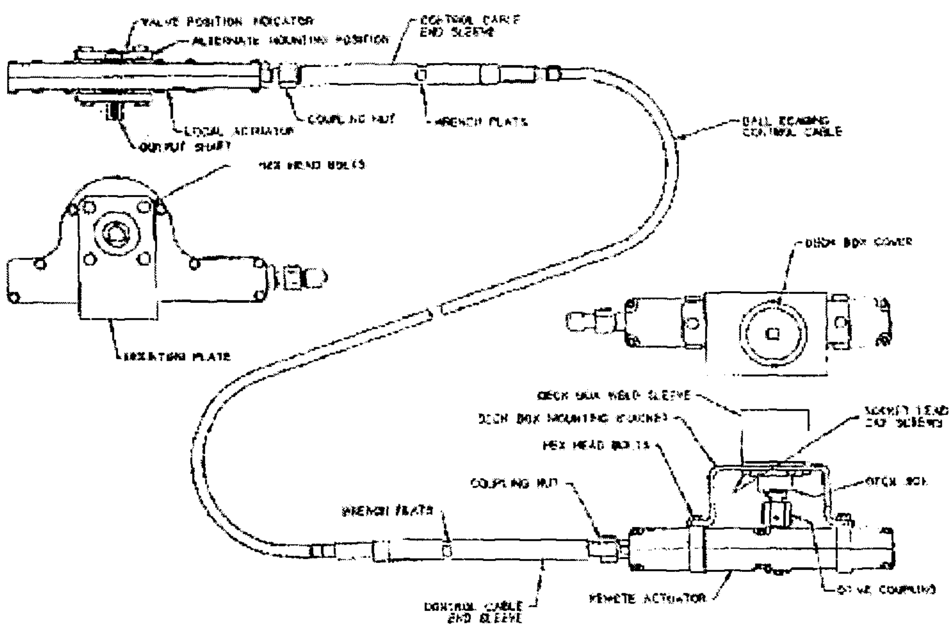


Figure 505-12-9. Quarter Turn Ball Bearing Remote Valve Operating System

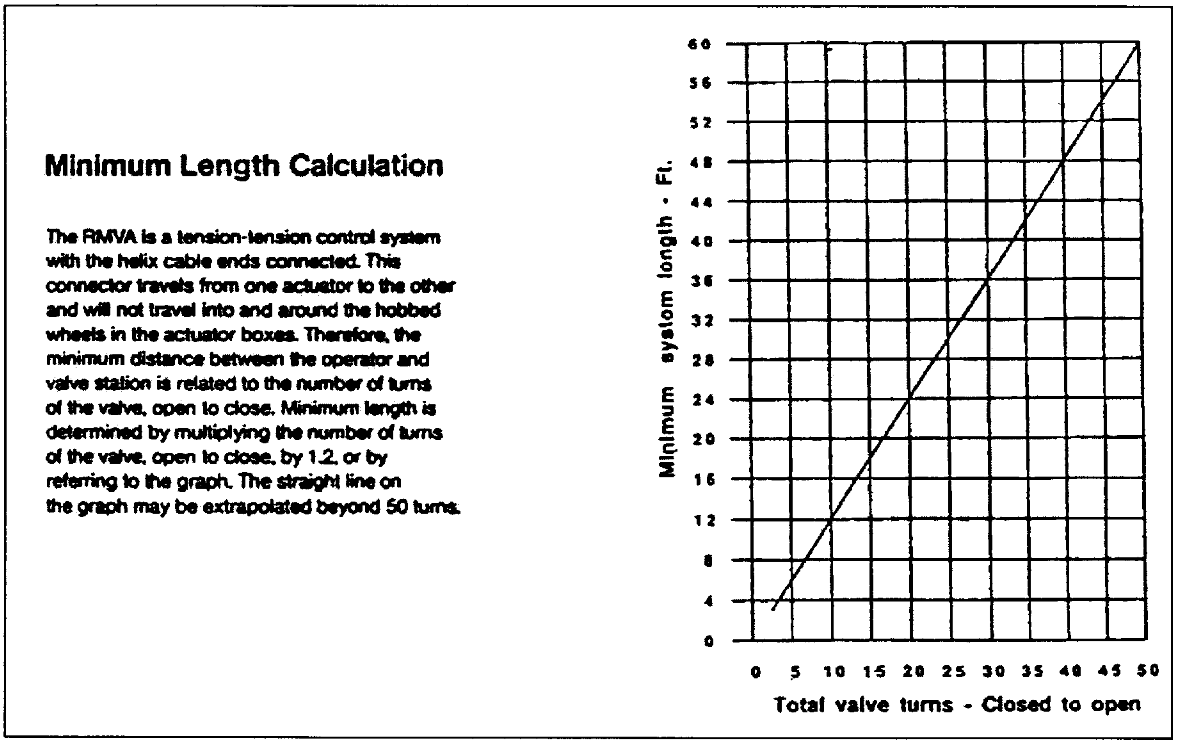
505-12.6 SELECTION CRITERIA.

There are several areas of consideration that must be taken into account during the selection of the ROG system. Each application must be made on an individual basis. It is not possible to procure one manufacturer's design and apply it to all the various situations on a ship. One of the first considerations that must be taken is the distance between the remote station and the valve being controlled. If the distance is more than 10 feet then rigid rod systems can be eliminated, unless otherwise approved. Also, if the distance is less than that determined from the table 505-12.1 below, then the Triumph Controls Dual Linear system having the rigid connector link can also be eliminated. The reason for this is that this system needs a minimum separation to obtain the turns needed to operate the valve from full open to full close otherwise the cable connector will be forced into the gearing causing failure. In the past, to avoid this situation, installers rapped excess cable around stantions, or coiled the excess in a convenient area, which is inefficient and is not approved. If the distance is less than two feet then the Elliott, Uniflex system can also be eliminated. Because flexible ROG's have a certain ″wind up″ associated with them, which vary with the resistance torque needed, the upper limit for ″wind up″ is 90 degrees. Where the system cable length is greater than 40 feet and the input torque approaches 45 ft-# then the Elliott and Teleflex systems should be verified that this wind up requirement is not exceeded. As a minimum, the following criteria should be considered when developing ROG performance specifications: (1) Available space at the valve and remote locations, (2) Type of remote operator required-i.e. flush mount or bulkhead mourned, (3) available space for conduit routings and bulkhead penetrations,(4) Environment conditions such as humidity, salt spray, heat, temperature and submergibility. It is imperative that valve operational ability and torque requirements are verified prior to any ROG installation. No ROG system will operate an inoperable (frozen) valve. Functional and mechanical correctness should be verified with valves exhibiting excessive torque requirements. Faulty valves should be overhauled or replaced to avoid potential damage to the ROG system. ROG systems have historically been identified as the culprit when a valve can not be remotely operated. In many instances valve failures are misidentified as ROG failures.

Valve manufacturer's data for a new valve should be scrutinized. A valve that has been in service for an extensive time will typically have dramatically different torque values when compared to an identical newly installed valve. System fluid/environment will have an adverse affect on the torque levels. Actual valve measurements when taken should include: breakaway, running and closure torque. The selected system should be capable of producing the maximum torque recorded.

The ROG systems described above have drive mechanisms that generate mechanical advantage delivering increased rotary torque to the valve. For example, a system utilizing a 4:1 mechanical advantage would require one full turn of the remote operator input device to completely open or close a 1/4 turn valve. If the same system were applied to a multi-turn valve such as a gate or globe valve requiring 20 turns to cycle (open or close) the valve, then 80 turns at the remote operator input device would be needed. This is an important aspect in developing ROG specifications. Wherever possible, the total number of turns at the remote operator should not exceed 40 full turns to either open or close a valve. Also the input torque should be limited to 45 ft-# of continuous input torque. It is understood that in some cases this maximum number of turns would have to be violated, in which case, the system having the lowest combined turns and input torque should be applied.

Table 505-12-1. TRIUMPH CONTROLS MINIMUM LENGTH DETERMINATION (where fixed link connector is used



The next criteria involve the maximum valve torque requirements. This value should be based on either the valve manufacturer's data or actual measurements on the valve. Because the manufacturer's data is likely to be nominal for a new valve, the torque should be increased by 200%. Actual data taken on installed valves should also be scrutinized for example if the valve has been in service for an extensive time then the torque value can be used directly without an increase, however, where torque values are taken on a newly installed valve, the measured torque should be increase by 200%. This increase is needed due to the likelihood that system fluid / environment will have an adverse affect on the torque levels. Actual valve measurements when taken should include: break-away, running and closure torque The selected system should be capable of producing the maximum torque recorded. Now in order for some systems to generate the required torque at the valve, the mechanical advantage may have to be increased. For example, if a system needs to use a 4:1 advantage then a 1/4 turn valve would be opened at the remote station with one full turn, however, if the valve is a multi-turn valve such as gate/globe where it takes 20 turns at the valve then the 4:1 gear ratio will cause the remote station to require 80 full turns to open/close the valve. This is an important aspect in selecting an ROG system. It is the intention of this selection guidance to limit the number of turns at the remote station to a maximum of 40 full turns. If the selected system requires more, then an alternate system needs to be used. Also, the torque needed at the remote station must be restricted to 45 ft-#. This will allow most personnel, the capability to operate the system. If the torque needed at the remote station is greater than 45ft-# a greater gear (mechanical advantage) ratio would have to be selected, however, then the maximum number of turns at the remote station could be violated. That is, for the same 1/4 turn valve if a 16:1 gear ratio is selected to increase the output torque at the valve then the number of turns at the remote station increase from one turn to four turns, which is acceptable, for this example, as long as the remote station torque is below 45ft-lb.

Once the maximum valve torque is established , along with the length of the system and total number of degrees of turns or bends in the system, the input torque of the system can be determined from the manufacturer's technical manuals. Input torque shall be limited to 45 ft-# and 90 degrees deflection (wind up), and system requiring higher number of turns needed to open/close the valve (at the valve) should be evaluated.

505-12.7 RIGID ROD DESIGN.

Where the distance between the remote station and the valve is ten feet or less it is recommended that the rigid rod system be considered first. First the offset between the remote station and the valve must be 30 degrees or less. This will allow a maximum of two universal joints to be used; each universal joint should be limited to a maximum angular misalignment 15 degrees. If the offset is greater than 30 degrees, the use of a gearbox and/or swivel maybe used. The overall efficiency of a rigid rod system should not be less than 50%. For example, if a system needs two universal joints, a swivel, and a gear box, the overall efficiency of this system is: 75%X75%X95%X95%=50%. The use of non-corrosive materials should also be utilized. Plus slip joints for allowing thermal expansion or structural movement, to avoid binding, slip joints shall be installed between any two rigidly mounted components. Remote stations shall have valve position indicators. Where compartment or bulkhead integrity has to be protected, stuffing boxes/tubes shall be utilized. Universal joints shall be installed as shown in the figure 505-12.10. The forks of the joints should be mounted parallel to one another. This will provide uniform rotation to the driven shaft because the second joint compensates the rotational error introduced by the first joint.

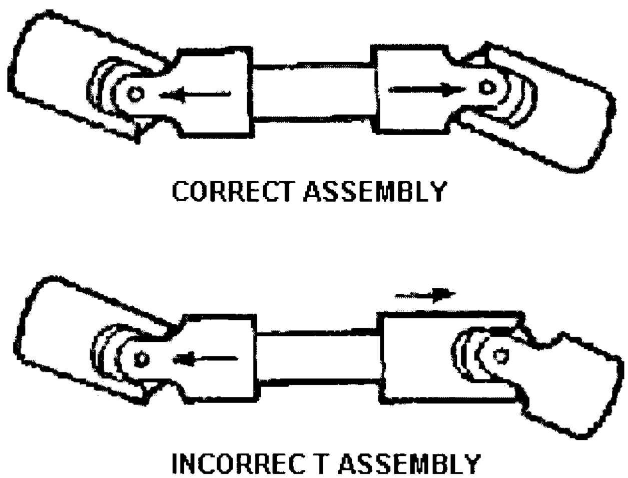


Figure 505-12-10. Universal joint

Quick Disconnect Couplings or Devices-Where the valve is in an accessible location; the ROG shall have a quick disconnect which would disengage the ROG to allow local operation of the valve. Torque required to operate valves vary widely among manufacturers, sizes, service and valve types. The table 505-12.2 below indicates the handwheel size and maximum tangential forces to provide the needed torque. The following table provides maximum hand wheel values, which are applicable for all ROG systems

Table 505-12-2. MAXIMUM ALLOWABLE VALVE SEATING FORCE

HANDWHEEL DIA (IN.)	MAXIMUM TANGENTIAL FORCE ON RIM OF HANDWHEEL (LBS.)	MAXIMUM EQUIVALENT TORQUE (LB-FT) AT CENTER OF STEM
2″ & BELOW	90	7.5
3	98	12
4	106	18
5	112	23

Table 505-12-2. MAXIMUM ALLOWABLE VALVE SEATING FORCE - Continued

HANDWHEEL DIA (IN.)	MAXIMUM TANGENTIAL FORCE ON RIM OF HANDWHEEL (LBS.)	MAXIMUM EQUIVALENT TORQUE (LB-FT) AT CENTER OF STEM
6	118	29
7	121	35
8	124	41
9	127	48
10	130	54
11	133	61
12	135	68
14	138	81
16	141	94
18	144	108
21	147	129
24	150	150
27	150	169
30	150	188
36	150	225

The following tables (table 505-12.3 and table 505-12.4) provide rigid rod component selection guidance for solid and tube diameters providing: rod diameters, allowable torque and the expected torsional deflection (backlash) in degrees/rod length (ft)/torque (ft-lb.).

Table 505-12-3. MECHANICAL PROPERTIES OF MIL-P–24691/1 TUBING

SIZE		POLAR MOMENT OF INERTIA lp (IN ^{4})	TORSIONAL DEFLECTION (DEG/FT/FT-LB)	ROD WEIGHT (LB/FT)	ALLOWABLE TWISTING MOMENT (FT-LBS)
O.D. (IN)	I.D. (IN)				
.840	.570	.039	.018	1.02	57.3
1.050	.780	.083	.008	1.32	98.8
1.315	1.045	.177	.004	1.70	167.8
1.660	1.390	.379	.0018	2.20	285.4
1.900	1.630	.586	.0012	2.54	385.8

Table 505-12-4. MECHANICAL PROPERTIES OF SOLID ROD

NOM. ROD DIA. (IN)	ACTUAL DIA. (IN)	POLAR MOMENT OF INERTIA lp (IN ^{4})	TORSIONAL DEFLECTION (DEG/FT/FT-LB)	ROD WEIGHT (LB/FT)	ALLOWABLE TWISTING MOMENT (FT-LBS)
5/8	.625/.622	.015	.046	1.04	26
3/4	.750/.747	.031	.022	1.50	45
1	1.000/.997	.098	.007	2.67	106
1-1/4	1.250/1.247	.240	.003	4.17	208
1-1/2	1.500/1.497	.497	.001	6.00	359

505-12.8 Pre/Post installation requirements.

The specifier should include requirements for final checkout once the system (s) are installed to assure that the ROG performs satisfactory. Any requirement for the supplier to visit the installation site during and after completion to inspect the system should be included in the contract. It is recommended that the ROG be cycled through a complete cycle to assure proper operation. Generally, it is recommended that the ROG supplier be included in the design, installation and acceptance testing of the system.

APPENDIX A

ACCEPTANCE CRITERIA FOR IN-SERVICE INSPECTIONS OF FASTENERS IN BOLTED JOINTS IN STEAM PIPING SYSTEMS OF NONNUCLEAR SURFACE SHIPS

505-A.1 ACCEPTANCE CRITERIA

505-A.1.1 PURPOSE. Provide criteria for determining acceptability of steam system bolted joints with possible discrepant fasteners. These criteria are for in-service inspections of existing installations only. These criteria are not to be used to determine fastener requirements for repair or installation of new components, which should instead utilize criteria established in specifications, such as technical repair standards or installation drawings. If none exist, then NSTM Chapter 505 and NSTM Chapter 075 should be used as guidance.

Justification: Clarified the meaning of ″specifications″, as recommended by comment (15.19).

505-A.1.2 SCOPE. These criteria apply to fasteners found installed in nonnuclear surface ship steam piping systems, specifically in joints requiring spiral-wound (flexitallic) gaskets. These systems include 1200-psi main steam through 100-psi auxiliary steam systems.

505-A.1.3 DEFINITIONS. The following definitions apply to the acceptance criteria described herein.

1. Acceptable Material Grade. Acceptable material grades are those specified in table 505-A-1 for the applicable temperature and pressure service.

2. Fastener. Any bolt and nut or stud and nut assembly.

   Justification: Editorial change as recommended by comment (120.01).

3. Fully Engaged Threads. Minimum thread protrusion is where the leading edge of the first male thread on the bolt or stud end is flush with the face of the nut.

4. Grade Markings. Permanent identifying markings on a fastener indicating the material and strength of the fastener. Grade markings for each material grade within the scope of these inspection criteria are summarized in table 505-A-2. For unmarked fasteners, see ″Criteria for Identification of Unmarked Fasteners″ in paragraph 505-A.1.5. Most fasteners also have manufacturers' markings as shown in figure 505-A-1.

5. Interim Acceptable Material Grade. Interim acceptable material grades are those specified in table 505-A-1 for the applicable temperature and pressure service.

6. Heavily Corroded Fastener. A bolt or stud which is corroded to the point that the diameter is noticeably reduced, based on visual inspection made without removing the bolt or stud.

7. Leakage. Steam passing through the pressure boundary of a joint. If the system is in service, leakage may be evidenced by a hissing noise, visually observing steam discharge, or confirmed by condensation on a mirror

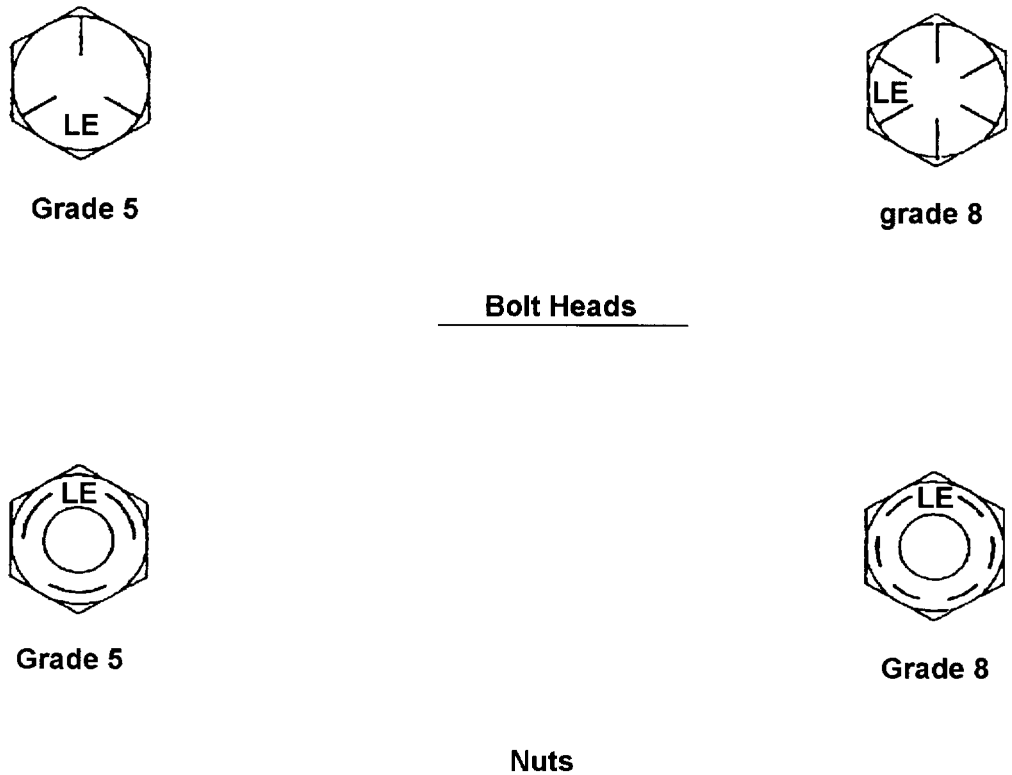


Figure 505-A-1. Fastener Markings

Justification: Added note 2 for clarification, as recommended bycomment (15.21). held next to the joint. If the system is not in service, leakage may be evidenced by steam cutting or oxidation (rust) patterns on the joint or by discoloration (charring), dampness, or wetting of lagging at the joint.

Justification: One thread protrusion is no longer required for existing joints, per GSO section 075b(b). Change recommended by comment (71.02). Added the paragraph number for ″Criteria for Identification of Unmarked Fasteners″ in sub-paragraph 4, as recommended by comment (15.20).

Table 505-A-1. STEAM PIPING FASTENER MATERIAL GRADE ACCEPTANCE STANDARDS (REFERENCES 1 AND 2)

Application and Temperature Conditions for Fasteners	Fasteners Qualified for Listed Application and Temperature Conditions [Note 2]				
	Acceptable Material Grade(s)		Interim Acceptable Material Grade(s) [Note 1]		
System Application	**Maximum Design Temperature**	**Bolt/Stud**	**Nut**	**Bolt/Stud [Note 3]**	**Nut**
1200-psi main steam	1000°F	B16	7	None	4, Stainless grades 304, 316, 321, 347
600-psi main steam	875°F	B16	H, 2H, 4, 7	B7, Monel grades 400, 405, 500	Monel grades 400, 405, and stainless grades 304, 316, 321, 347, 305, 384, XM7
400-psi service steam	875°F	B16	H, 2H, 4, 7	B7, Monel grades 400, 405, 500	Monel grades 400, 405, and stainless grades 304, 316, 321, 347, 305, 384, XM7
100-psi auxiliary steam	875°F	B16	H, 2H, 4, 7	B7, Monel grades 400, 405, 500	Monel grades 400, 405, and stainless grades 304, 316, 321, 347, 305, 384, XM7
1200-psi auxiliary or desuperheated steam	775°F	B7, B16	H, 2H, 4, 7	Monel grades 400, 405, 500	Monel grades 400, 405, and stainless grades 304, 316, 321, 347, 305, 384, XM7
600-psi desuperheated steam	775°F	B7, B16	H, 2H, 4, 7	Monel grades 400, 405, 500	Monel grades 400, 405, and stainless grades 304, 316, 321, 347, 305, 384, XM7
400-psi auxiliary steam	775°F	B7, B16	H, 2H, 4, 7	Monel grades 400, 405, 500	Monel grades 400, 405, and stainless grades 304, 316, 321, 347, 305, 384, XM7
150-psi auxiliary steam	775°F	B7, B16	H, 2H, 4, 7	Monel grades 400, 405, 500	Monel grades 400, 405, and stainless grades 304, 316, 321, 347, 305, 384, XM7
150-psi auxiliary steam	550°F	B7, B16	H, 2H, 4, 7	8	8
1200-psi steam overboard discharge	650°F	Monel grades 400, 405, 500	Monel grades 400, 405	B7, B16, L7, 2, 8, stainless grades 304, 316, 321, 347	H, 2H, 2, 4, 7, 8, stainless grades 304, 316, 321, 347, 305, 384, XM7
600-psi steam overboard discharge	650°F	Monel grades 400, 405, 500	Monel grades 400, 405	B7, B16, L7, 2, 8, stainless grades 304, 316, 321, 347	H, 2H, 2, 4, 7, 8, stainless grades 304, 316, 321, 347, 305, 384, XM7

Notes:
1. Interim acceptability of these materials applies only when all the specified conditions of Category 2, part (2), are met. These materials shall not be considered acceptable (interim or otherwise) under any other conditions.

Table 505-A-1. STEAM PIPING FASTENER MATERIAL GRADE ACCEPTANCE STANDARDS

(REFERENCES 1 AND 2) - Continued

Application and Temperature Conditions for Fasteners	**Fasteners Qualified for Listed Application and Temperature Conditions** Note 2				
	Acceptable Material Grade(s)		**Interim Acceptable Material Grade(s)** Note 1		
System Application	**Maximum Design Temperature**	**Bolt/Stud**	**Nut**	**Bolt/Stud** Note 3	**Nut**
2. Cadmium plated fasteners are only allowed up to 400°F and zinc plated fasteners are only allowed up to 300°F.					
3. See NSTM Chapter 075 for a more comprehensive discussion of strength characteristics and marking of 300 series stainless steels.					
Justification: Grade 5 nut material is not acceptable over 650°F. Most Grade 5 fasteners are either cadmium or zink plated in which cases the temperatures should be limited to 400°F or 300°F respectively. Stainless grades 305, 384, and XM7 are in the same allow group as 304 and considered interchangable. Monel alloy 500 should not be used for nuts because of galling. Various restrictions on use of stainless steel bolt/studs are discussed in NSTM Chapter 075. Changes recommended by comments (15.22a), (15.22b), (15.22c), and (15.22e). Also see comments (15.22d) and (108.75).					

Table 505-A-2. FASTENER CHARACTERISTICS

Type Fastener	Material Grade *	Head Marking	Magnetic Characteristics	Material Composition *
Bolt or Stud	2 (Carbon Steel)	None	Strongly magnetic	Carbon: 0.55% (max)
				Phosphorus: 0.048% (max)
				Sulfer: 0.058% (max)
	5 (Carbon Steel)	Three radial lines (See figure 505-A-1)	Strongly magnetic	Carbon: 0.28-0.55%
				Phosphorus: 0.048% (max)
				Sulfer: 0.058% (max)
	8 (Carbon Steel)	Six radial lines (See figure 505-A-1)	Strongly magnetic	Carbon: 0.28-0.55%
				Phosphorus: 0.040% (max)
				Sulfer: 0.045% (max)
	B7 (Alloy Steel)	B7	Strongly magnetic	Carbon: 0.37-0.49%
				Manganese: 0.65-1.10%
				Phosphorus: 0.035% (max)
				Sulfer: 0.040% (max)
				Silicon: 0.15-0.35%
				Chromium: 0.75-1.20%
				Molybdenum: 0.15-0.25%
	L7 (Alloy Steel)	L7	Strongly magnetic	Carbon: 0.38-0.48%
				Manganese: 0.75-1.00%
				Phosphorus: 0.035% (max)
				Sulfer: 0.040% (max)
				Silicon: 0.15-0.35%
				Chromium: 0.80-1.10%
				Molybdenum: 0.15-0.25%
	B16 (Alloy Steel)	B16	Strongly magnetic	Carbon: 0.36-0.47%
				Manganese: 0.45-0.70%
				Phosphorus: 0.035% (max)
				Sulfer: 0.040% (max)
				Silicon: 0.15-0.35%
				Chromium: 0.80-1.15%
				Molybdenum: 0.50-0.65%
				Vanadium: 0.25-0.35%
	400 (Nickel-Copper)	400, NC, NICU, F 468V	Nonmagnetic or magnetic, but not as strongly magnetic as steel	Nickel: 63-70%
				Iron: 2.5% (max)
				Aluminum: 0.5% (max)

Table 505-A-2. FASTENER CHARACTERISTICS - Continued

Type Fastener	Material Grade *	Head Marking	Magnetic Characteristics	Material Composition *
				Manganese: 2.0% (max)
				Carbon: 0.2% (max)
				Silicon: 0.5% (max)
	405 (Nickel-Copper)	405, NCR, NICU/R, F 468V	Nonmagnetic or magnetic, but not as strongly magnetic as steel	Nickel: 63-70%
				Iron: 2.5% (max)
				Aluminum: 0.5% (max)
				Manganese: 2.0% (max)
				Carbon: 0.3% (max)
				Silicon: 0.5% (max)
	500 (Nickel-Copper-Aluminum)	500, K, NICU, K, F 468W	Nonmagnetic	Nickel: 63% (mm)
				Iron: 2.5% (max)
				Aluminum: 2.3-3.15%
				Carbon: 0.25% (max)
				Silicon: 0.5% (max)
				Titanium: 0.35-0.85%
	304 (Stainless Steel)	B8, B8A, 304, F593C, F593D, or none	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)
				Manganese: 2.00% (max)
				Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Chromium: 18-20%
				Nickel: 8-10.5%
	316 (Stainless Steel)	B8M, B8MA, 316, F593G,	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)
				Manganese: 2.00% (max)
		F593H, or none		Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Chromium: 16-18%
				Nickel: 10-14%
				Molybdenum: 2-3%
	321 (Stainless Steel)	B8T, B8TA, 321, F593L, F593M, or none	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)

Table 505-A-2. FASTENER CHARACTERISTICS - Continued

Type Fastener	Material Grade *	Head Marking	Magnetic Characteristics	Material Composition *
				Manganese: 2.00% (max)
				Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Nickel: 9-12%
				Chromium: 17-19%
				Titanium: 5 x carbon content (min)
	347 (Stainless Steel)	B8C, B8CA, 347, F593L, F593M, or none	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)
				Manganese: 2.00% (max)
				Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Chromium: 17-19%
				Nickel: 9-13%
				Columbium + Tantalum: 10 x Carbon content (min)
Nut	H (Steel)	H	Strongly magnetic	Sulfer: 0.050% (max)
				Phosphorus: 0.050% (max)
	2H (Alloy Steel)	2H	Strongly magnetic	Carbon: 0.40% (min)
				Phosphorus: 0.040% (max)
				Sulfer: 0.050% (max)
				Manganese: 1.00% (max)
				Silicon: 0.40% (max)
	2 (Carbon Steel)	None	Strongly magnetic	Carbon: 0.47% (max)
				Phosphorus: 0.12% (max)
				Sulfer: 0.15% (max)
	4 (Alloy Steel)	4	Strongly magnetic	Carbon: 0.40-0.50%
				Manganese: 0.70-0.90%
				Phosphorus: 0.035% (max)
				Sulfer: 0.040% (max)
				Silicon: 0.15-0.35%
				Molybdenum: 0.20-0.30%
	5 (Carbon Steel)	Three circumferential dashes (See figure 505-A-1)	Strongly magnetic	Carbon: 0.55% (max)
				Manganese: 0.30% (min)

Table 505-A-2. FASTENER CHARACTERISTICS - Continued

Type Fastener	Material Grade *	Head Marking	Magnetic Characteristics	Material Composition *
				Phosphorus: 0.05% (max)
				Sulfer: 0.015% (max)
	7 (Alloy Steel)	7	Strongly magnetic	Carbon: 0.37-0.49%
				Manganese: 0.65-1.10%
				Phosphorus: 0.04% (max)
				Sulfer: 0.04% (max)
				Silicon: 0.15-0.35% (max)
				Chromium: 0.75-1.20%
				Molybdenum: 0.15-0.25%
	8 (Carbon Steel)	Six circumferential dashes (See figure 505-A-1)	Strongly magnetic	Carbon: 0.55% (max)
				Manganese: 0.30% (max)
				Phosphorus: 0.04% (max)
				Sulfer: 0.05% (max)
	400 (Nickel-Copper)	400, NC, NICU, F 467U	Nonmagnetic or magnetic, but not as strongly magnetic as steel	Nickel: 63-70%
				Iron: 2.5% (max)
				Aluminum: 0.5% (max)
				Manganese: 2.0% (max)
				Carbon: 0.2% (max)
				Silicon: 0.5% (max)
	400 (Nickel-Copper)	405, NC-R, NCR, NICU/R, F 467V	Nonmagnetic or magnetic, but not as strongly magnetic as steel	Nickel: 63-70%
				Iron: 2.5% (max)
				Aluminum: 0.5% (max)
				Manganese: 2.0% (max)
				Carbon: 0.3% (max)
				Silicon: 0.5% (max)
	500 (Nickel-Copper-Aluminum)	500, K NICU, K, F 467W	Nonmagnetic	Nickel: 63% (min)
				Iron: 2.0 (max)%
				Aluminum: 2.3-3.15%
				Carbon: 0.25% (max)
				Silicon: 0.5% (max)
				Titanium: 0.35-0.85%

Table 505-A-2. FASTENER CHARACTERISTICS - Continued

Type Fastener	Material Grade *	Head Marking	Magnetic Characteristics	Material Composition *
	304 (Stainless Steel)	8, 8A, 8B, 304, F594C, F594D, or none	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)
				Manganese: 2.00% (max)
				Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Chromium: 18-20%
				Nickel: 8-10.5%
	316 (Stainless Steel)	8M, 8MA, 8MB, 316, F594G, F594H, or none	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)
				Manganese: 2.00% (max)
				Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Chromium: 16-18%
				Nickel: 10-14%
				Molybdenum: 2-3%
	321 (Stainless Steel)	8T, 8TA, 8TB, 321, F594L, F594M, or none	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)
				Manganese: 2.00% (max)
				Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Chromium: 17-19%
				Nickel: 9-12%
				Titanium: 5 x Carbon content (min)
	347 (Stainless Steel)	8C, 8CA, 8CB, 347, or none	Nonmagnetic to slightly magnetic	Carbon: 0.08% (max)
				Manganese: 2.00% (max)
				Phosphorus: 0.045% (max)
				Sulfer: 0.030% (max)
				Silicon: 1.00% (max)
				Chromium: 17-19%
				Nickel: 9-13%

Table 505-A-2. FASTENER CHARACTERISTICS - Continued

Type Fastener	Material Grade *	Head Marking	Magnetic Characteristics	Material Composition *
				Columbium + Tantalum: 10 x carbon content (min)
* References: ASTM A193, A329, F593, SAE J429, QQ-N-281, QQ-N-286.				
Note: See NSTM Chapter 075 for a more comprehensive discussion of strength characteristics and marking of 300 series stainless steels.				
Justification: Corrected several typos. Various restrictions on use of stainless steel bolt/studs are discussed in NSTM Chapter 075. ″Monel″ and ″K-Monel″ are proprietary trade names. Changes recommended by comments (15.22e), (15.23b), and (15.23c). Also see comments (15.23a) and (108.75).				

505-A.1.4 ACCEPTANCE CRITERIA FOR FASTENERS IN BOLTED JOINTS. This section first lists the criteria which determine the acceptance category for a joint: acceptable, interim acceptable, or unacceptable. Then for each category, the service restrictions for the joint and required corrective actions are provided.

505-A.1.4.1 Acceptance Categories.

505-A.1.4.1.1 Category 1 - Joint Acceptable As Is. Joints are considered Category 1 when all of the following criteria are met:

1. Joint shows no indication of recent leakage.
2. All fasteners in the joint are considered to be an acceptable material grade (see table 505-A-1).
3. All fasteners in the joint are the correct nominal diameter for the flange size and class (see table 505-A-3).
4. All fasteners have fully engaged threads.
5. No fasteners are heavily corroded.
6. No fasteners are missing.
7. All nuts and bolt heads are tight against the flange (visual inspection only).

505-A.1.4.1.2 Category 2 - Joint Acceptable on an Interim Basis. Joints are considered Category 2 when either item 1. or 2. below is met:

1. The joint shows no indication of recent leakage. Additionally, some fasteners in a joint can have the discrepancies listed below; however, the number of fasteners with discrepancies cannot exceed the number indicated in table 505-A-4.
   a. The fastener material is not an acceptable material grade (see table 505-A-1).
   b. The fastener is the wrong nominal diameter (see table 505-A-3).
   c. The fastener is heavily corroded.
   d. The fastener does not have fully engaged threads.
   e. The fastener is missing.
   f. The fastener is loose (i.e., nut or bolt head is not tight against the flange based on visual inspection).
2. The fasteners in the joint are any combination of acceptable and interim acceptable materials (see table 505-A-1) and:
   a. The joint shows no indication of recent leakage.
   b. All fasteners in the joint are the correct nominal diameter for the flange size and class (see table 505-A-3).
   c. All fasteners have fully engaged threads.
   d. No fasteners are heavily corroded.

Table 505-A-3. BOLT OR STUD DIAMETER FOR SPECIFIC CLASS FLANGES WITH REFERENCE LISTINGS OF PIPE SIZE, FLANGE THICKNESS, AND NUMBER OF FLANGE BOLTS OR STUDS (REFERENCE: ANSI B16.5) (Sheet 1 of 3)

		Class 2500 Flanges			Class 1500 Flanges		
Nominal Pipe Size (in.)	**Pipe Outside Diameter (in.)**	**Flange Thickness, * Minimum (in.)**	**Number of Flange Bolts or Studs**	**Bolt or Stud Diameter (in.)**	**Flange Thickness, * Minimum (in.)**	**Number of Flange Bolts or Studs**	**Bolt or Stud Diameter (in.)**
1/2	0.840	1.19	4	3/4	0.88	4	3/4
3/4	1.050	1.25	4	3/4	1.00	4	3/4
1	1.315	1.38	4	7/8	1.12	4	7/8
1-1/4	1.660	1.50	4	1	1.12	4	7/8
1-1/2	1.900	1.75	4	1-1/8	1.25	4	1
2	2.375	2.00	8	1	1.50	8	7/8
2-1/2	2.875	2.25	8	1-1/8	1.62	8	1
3	3.500	2.62	8	1-1/4	1.88	8	1-1/8
4	4.500	3.00	8	1-1/2	2.12	8	1-1/4
5	5.563	3.62	8	1-3/4	2.88	8	1-1/2
6	6.625	4.25	8	2	3.25	12	1-3/8
8	8.625	5.00	12	2	3.62	12	1-5/8
10	10.750	6.50	12	2-1/2	4.25	12	1-7/8
12	12.750	7.25	12	2-3/4	4.88	16	2
* See figure 505-A-2							

Table 505-A-3. BOLT OR STUD DIAMETER FOR SPECIFIC CLASS FLANGES WITH REFERENCE LISTINGS OF PIPE SIZE, FLANGE THICKNESS, AND NUMBER OF FLANGE BOLTS OR STUDS (REFERENCE: ANSI B16.5) (Sheet 2 of 3)

Nominal Pipe Size (in.)	Pipe Outside Diameter (in.)	Class 600 Flanges Applied in 600 psi, Main and Auxiliary Steam and Overboard Steam Discharge Systems			Class 400 Flanges Applied in 400 psi, Main, Auxiliary and Service Steam and Overboard Steam Discharge Systems		
		Flange Thickness, * Minimum (in.)	Number of Flange Bolts or Studs	Bolt or Stud Diameter (in.)	Flange Thickness, * Minimum (in.)	Number of Flange Bolts or Studs	Bolt or Stud Diameter (in.)
1/2	0.840	0.56	4	1/2	0.56	4	1/2
3/4	1.050	0.62	4	5/8	0.62	4	5/8
1	1.315	0.69	4	5/8	0.69	4	5/8
1-1/4	1.660	0.81	4	5/8	0.81	4	5/8
1-1/2	1.900	0.88	4	3/4	0.88	4	3/4
2	2.375	1.00	8	5/8	1.00	8	5/8
2-1/2	2.875	1.12	8	3/4	1.12	8	3/4
3	3.500	1.25	8	3/4	1.25	8	3/4
3-1/2	4.000	1.38	8	7/8	1.38	8	7/8
4	4.500	1.50	8	7/8	1.38	8	7/8
5	5.563	1.75	8	1	1.50	8	7/8
6	6.625	1.88	12	1	1.62	12	7/8
8	8.625	2.19	12	1-1/8	1.88	12	1
10	10.750	2.50	16	1-1/4	2.12	16	1-1/8
12	12.750	2.62	20	1-1/4	2.25	16	1-1/4

* See figure 505-A-2

Table 505-A-3. BOLT OR STUD DIAMETER FOR SPECIFIC CLASS FLANGES WITH REFERENCE LISTINGS OF PIPE SIZE, FLANGE THICKNESS, AND NUMBER OF FLANGE BOLTS OR STUDS (REFERENCE: ANSI B16.5) (Sheet 3 of 3)

		Class 300 Flanges Applied in 300 psi, Auxiliary and Service Steam Systems			Class 150 Flanges Applied in 150 psi, Auxiliary Steam Systems		
Nominal Pipe Size (in.)	Pipe Outside Diameter (in.)	Flange Thickness, * Minimum (in.)	Number of Flange Bolts or Studs	Bolt or Stud Diameter (in.)	Flange Thickness, * Minimum (in.)	Number of Flange Bolts or Studs	Bolt or Stud Diameter (in.)
1/2	0.840	0.50	4	1/2	0.38	4	1/2
3/4	1.050	0.56	4	5/8	0.44	4	1/2
1	1.315	0.63	4	5/8	0.50	4	1/2
1-1/4	1.660	0.69	4	5/8	0.56	4	1/2
1-1/2	1.900	0.75	4	3/4	0.63	4	1/2
2	2.375	0.82	8	5/8	0.69	4	5/8
2-1/2	2.875	0.94	8	3/4	0.82	4	5/8
3	3.500	1.06	8	3/4	0.88	4	5/8
3-1/2	4.000	1.13	8	3/4	0.88	8	5/8
4	4.500	1.19	8	3/4	0.88	8	5/8
5	5.563	1.32	8	3/4	0.88	8	3/4
6	6.625	1.38	12	3/4	0.94	8	3/4
8	8.625	1.56	12	7/8	1.06	8	3/4
10	10.750	1.82	16	1	1.13	12	7/8
12	12.750	1.96	16	1-1/8	1.19	12	7/8

* See figure 505-A-2.

Note: Thickness adjusted from ANSI B16.5 requirements to account for measurement specified in figure 505-A-2.

e. No fasteners are missing.

f. All nuts and bolt heads are tight against the flange (visual inspection only).

Justification: No change, but see comment (15.24b).

Table 505-A-4. ALLOWABLE NUMBER OF FASTENER DISCREPANCIES FOR BOLTED FLANGE CONNECTIONS (REFERENCE 2)

Nominal Pipe Size (in.)	Allowable Number of Fastener Discrepancies *				
	Class 150	**Class 300**	**Class 400**	**Class 600**	**Class 1500**
1/2	1	1	N/A	1	1
3/4	0	1	N/A	1	1
1	0	0	N/A	0	1
1 1/4	0	0	N/A	0	1
1 1/2	0	0	N/A	0	1
2	0	2	N/A	2	2
2 1/2	0	2	N/A	2	2
3	0	2	N/A	1	2
3 1/2	1	1	N/A	1	N/A
4	1	1	1	1	2
5	0	1	1	1	2
6	0	1	1	1	3
8	0	0	1	0	3
* When the bolt and/or the attached nut are discrepant, consider this as a single fastener discrepancy. Similarly, when the stud and/or one or both of the attached nuts are discrepant, consider this as a single fastener discrepancy.					
Justification: Center the table title as recommended by comment (70.16).					

505-A.1.4.1.3 Category 3 - Joint Requiring Immediate Corrective Action. All bolted joints not meeting the Category 1 or Category 2 criteria are considered Category 3.

505-A.1.4.2 Acceptance For Service And Maintenance Policy.

505-A.1.4.2.1 Category 1. Joint is acceptable for continued service, as is, providing subsequent routine maintenance and/or in-service inspections reveal no degradation in condition.

505-A.1.4.2.2 Category 2. Joint is acceptable on an interim basis for normal service. Corrective maintenance or repair of the joint to bring all fasteners and flanges of the joint to specifications is required as follows:

1. Within six months or during the current or next industrial availability, whichever occurs first.
2. If the joint cannot be corrected to specifications within the above time frame, a Departure from Specifications (DFS) must be submitted and approved through appropriate TYCOM procedures.
3. If the joint is within the Level I piping boundary, a Departure from Specifications must be submitted and approved, regardless.

505-A.1.4.2.3 Category 3. Joint requires immediate corrective maintenance or repair to bring the fasteners and flanges to specifications. If, for operational reasons, the system cannot be secured, this fact must be approved by the Commanding Officer, and the system must be operated with due regard to the safety risk, and a DFS must be submitted. If the system can be repaired immediately, yet only to Category 2 condition, a Departure from Specifications is required immediately.

Justification: Changed "l" to "or" in the last two paragraphs as an editorial change as recommended by comment (120.01).

505-A.1.5 CRITERIA FOR IDENTIFICATION OF UNMARKED FASTENERS. Unmarked fasteners or fasteners with obliterated or unreadable grade markings are acceptable when all of the following criteria are met:

1. When checked with a magnet, all unmarked fasteners in the joint exhibit the correct magnetism for the acceptable material grade per table 505-A-2.
2. The material composition (table 505-A-2) of at least one unmarked bolt or stud and one unmarked nut (if nuts are installed) in the joint is verified by qualified personnel using one of the following methods:
   a. Material identification using an alloy analyzer such as the Texas Nuclear Alloy Analyzer, Model 9266, or equivalent.
   b. Material identification using an acid spot test.
3. All unmarked fasteners appear to be of similar material, design, manufacture, and coating, based on visual inspection. Fasteners used in steam systems should not have zinc or cadmium coating. Caution should be used when coated fasteners are encountered in steam systems since these fasteners are usually not coated. Installed black oxide coated nickel-copper or ceramic coated steel may be retained when the base material is acceptable.

   Justification: Clarified the acceptability of coated fasteners in steam systems, as recommended by comment (15.24a).

505-A.2 PROCEDURE FOR APPLYING THE ACCEPTANCE CRITERIA FOR FASTENER INSPECTIONS

505-A.2.1 PURPOSE. Present the sequence for inspecting bolted joints, determining acceptance criteria for the joint fasteners, performing fastener inspections, and comparing the inspection results with acceptance criteria.

505-A.2.2 SCOPE. This procedure implements the steps contained in section A.1, "Acceptance Criteria." Accordingly, the procedure should not be applied without the companion acceptance criteria or applied to fasteners or systems not covered by the acceptance criteria.

505-A.2.3 PROCEDURE. Apply the listed steps of the procedure in the order presented. Steps refer to items on an Inspection Checklist following this procedure.

NOTE

All tables and figures referenced in this section are contained in the Acceptance Criteria (section A.1).

a. Identify and categorize joint:
   1. Note system where joint is installed and record this as Item 1 on Inspection Checklist.
   2. Record a description of the joint and its location in Item 11, Inspection Results, on Inspection Checklist.
   3. Inspect joint for indications of recent or active leakage. Indicate in Item 2 of Inspection Checklist whether there are indications of recent or active joint leakage.

NOTE

If the system is in service, leakage may be evidenced by a hissing noise, visually observing steam discharge, or confirmed by condensation on a mirror held next to the joint. If the system is not in service, leakage may be evidenced by steam cutting or oxidation (rust) patterns on the joint or by discoloration (charring), dampness, or wetting of lagging at the joint.

4. Measure the flange thickness (figure 505-A-2) and pipe outside diameter (OD) (if accessible). Record flange thickness and pipe OD on Items 3 and 5, respectively, on Inspection Checklist.

5. Using table 505-A-3, determine required class of flange, nominal pipe size, number of bolts, and size of bolts. Record these as Items 4, 6, 7 and 8, respectively, on Inspection Checklist.

6. Using table 505-A-1, determine the acceptable material grades of the bolt or stud, and nut for the steam system and record these as Items 9 and 10, respectively, on Inspection Checklist.

   Justification: Changed "l" to "or"as an editorial change as recommended by comment (120.01).

b. Inspect fasteners for each fastener in the joint:

1. Inspect the bolt/stud and attached nut(s) for grade markings. Determine material grade corresponding to grade markings using table 505-A-2. Record the material grade of each bolt/stud and attached nut in Item 11, Inspection Results, of Inspection Checklist.

NOTE

If the grade markings are not visible or are unreadable, apply Criteria for Unmarked Fasteners.

2. Measure diameter of bolt or stud (outer diameter of thread closely approximates nominal diameter of fastener). Record in Item 11, Inspection Results, of Inspection Checklist if diameter is correct or incorrect, (* for correct, x for incorrect) compared with Item 8 requirement.

3. Visually check for proper thread arrangement, corrosion, missing bolt or stud or nut(s), and tightness, and record as acceptable (*) or unacceptable (x) in Item 11, Inspection Results, of Inspection Checklist.

   Justification: Changed "l" to "or" in the last two paragraphs as an editorial change as recommended by comment (120.01).

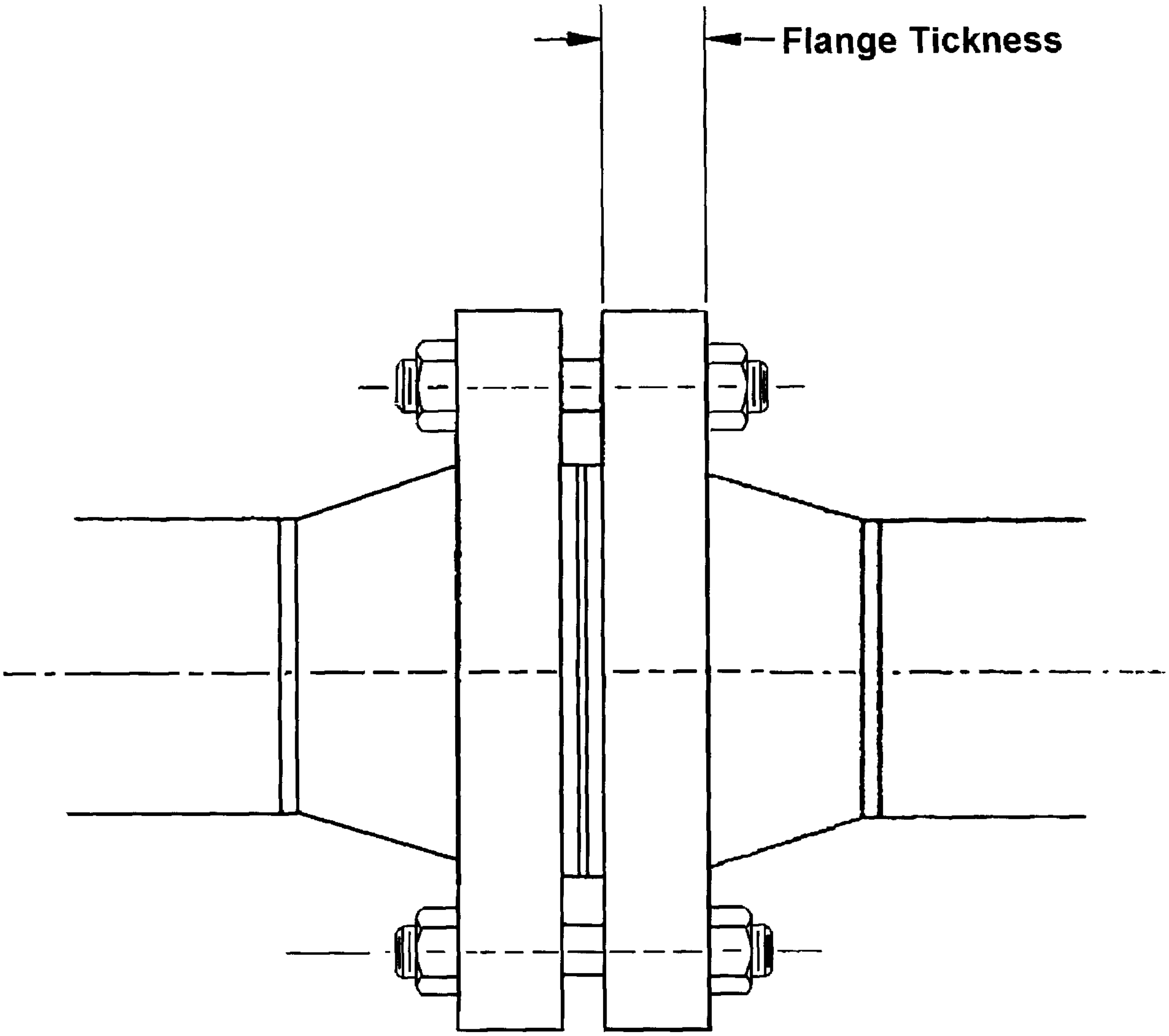


Figure 505-A-2. Flange Thickness Measurement

c. Determine acceptance category:

1. If joint shows signs of leakage, it is Category 3 - Unacceptable: proceed to step d. Otherwise continue with step c.2.
2. Referring to Item 11, Inspection Results, of the Inspection Checklist, count number of discrepant fasteners. A fastener is discrepant if one or more of the following conditions exist:
   (a) The bolt or stud material is not one of the acceptable materials identified in Item 9 of the Inspection Checklist.

   Justification: Changed ″/″ to ″or″ as an editorial change as recommended by comment (120.01).

   (b) The nut(s) material is not one of the acceptable materials identified in Item 10 of the Inspection Checklist.

   (c) Any Stud/Bolt/Nut Conditions Acceptable box for the fastener is marked with an ″x″.
3. If no fasteners are discrepant, the joint is Category 1 - Acceptable: proceed to step d. Otherwise continue with step c.4.
4. Compare the number of discrepant fasteners with the allowed number of discrepant fasteners from table 505-A-4. If the number of discrepant fasteners is less than or equal to the allowed number, the joint is Category 2 - Interim Acceptable: proceed to step d. Otherwise continue with step c.5.
5. If any fastener has one or more Stud/Bolt/Nut Conditions Acceptable boxes marked with an ″x,″ the joint is Category 3 - Unacceptable: proceed to step d. Otherwise continue with step c.6.
6. Compare the material grades of each discrepant fastener with the interim acceptable material grades identified in table

505-A-1. If all discrepant materials are interim acceptable materials per table 505-A-1, the joint is Category 2 - Interim Acceptable. Otherwise the joint is Category 3 - Unacceptable.

The above logic process for reviewing the number of fastener discrepancies and determining joint acceptance is illustrated in figure 505-A-3.

d. Circle acceptance category determined in step c.

e. Sign and date Inspection Checklist.

f. Have officer in charge approve Inspection Checklist.

NOTE

Checklist approver must review checklist data and concur with acceptance category before signing and dating.

g. Disposition joint using the Section 1, Acceptance Criteria, Part B - Acceptance for Service and Maintenance Policy. This policy provides guidance for accepting a joint and prescribes corrective maintenance for interim acceptable or unacceptable joints.

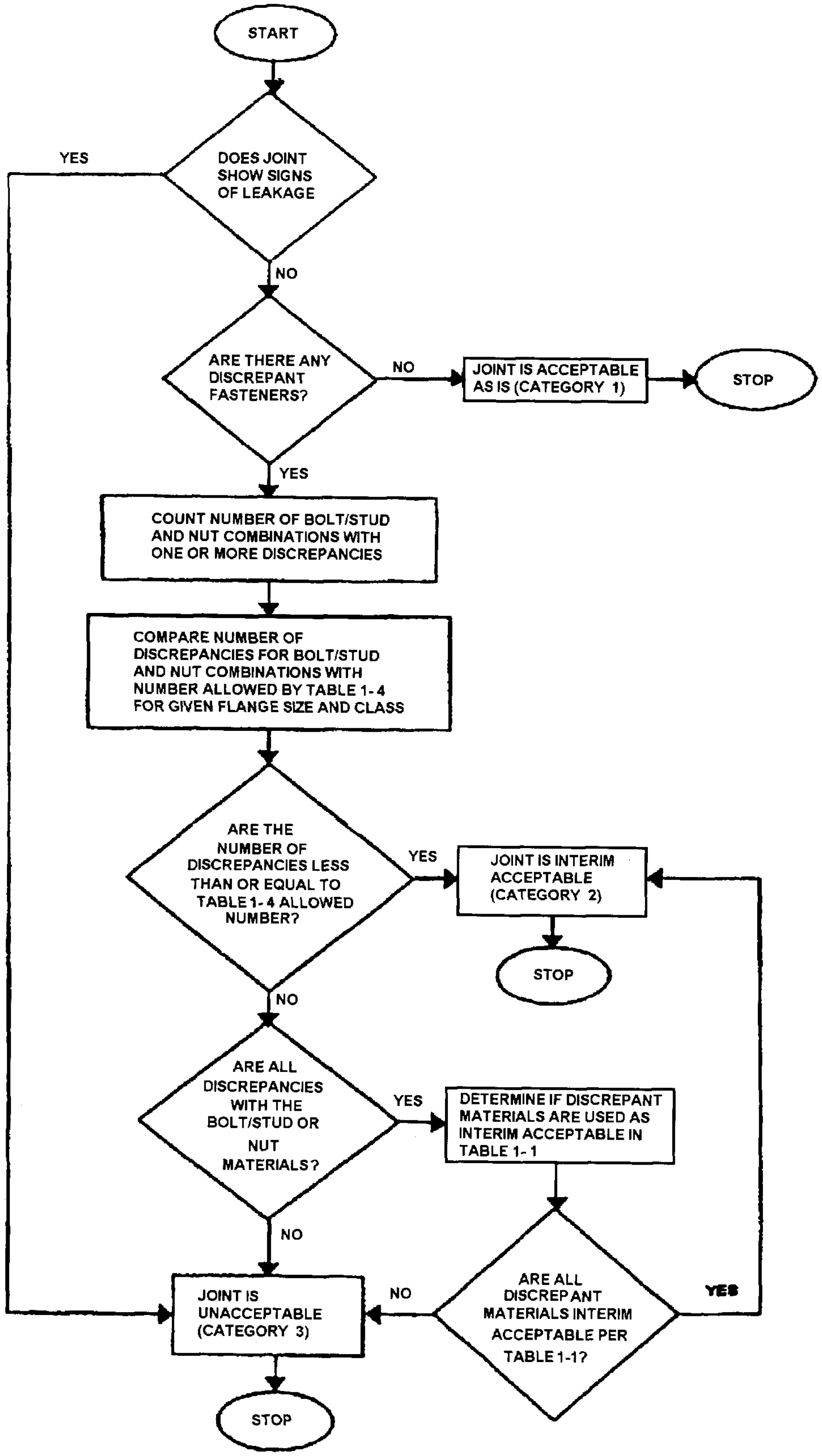


Figure 505-A-3. Logic Diagram for Reviewing the Number of Fastener Discrepancies to Determine Joint Acceptance

INSPECTION CHECKLIST [1]

COPY AND USE THIS FORM FOR JOINT INSPECTIONS

1. Application___________
2. Indication of Recent Joint Leakage Yes___ No____
3. Flange Thickness (per Figure 1-2) __________
4. Class of Flange (per Table 1-3) __________
5. Pipe Outside Diameter (verify per Table 1-3 using flange thickness) ___________
6. Nominal Pipe Size (per Table 1-3) __________
7. Number of required Bolts or Studs (per Table 1-3) __________
8. Required Bolt or Stud Diameter (per Table 1-3) ________inch
9. Acceptable Bolt or Stud Grade (per Table 1-1) ____________
10. Acceptable Nut Grade (per Table 1-1) ___________
11. Inspection Results:

Joint Description/Location:							
Fastener Number[2]	Actual Material[3]		Stud or Bolt or Nut Conditions Acceptable				
	Stud or Bolt	Nut(s)	Correct Stud or Bolt Diameter	Fully Engaged Thread	Not Heavily Corroded	Not Missing	Tight Against Flange
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

12. Per Acceptance Criteria, Circle one Acceptance Category:

Category 1 - Acceptable[4]   Category 2 - Interim Acceptable[5]   Category 3 - Unacceptable[6]

13. Inspected by: ____ Date __________

14. Approved by: ____ Date __________

[1] Applies only to installed fasteners in non-nuclear surface ship steam system bolted pipe joints.
[2] Fastener number is arbitrary, depending on local procedure (could start with No. 1 at 12 o'clock and proceed clockwise).
[3] Per markings on fasteners or per "Criteria for Identification of Unmarked Fasteners" if unmarked.
[4] Acceptable for continued service.
[5] Repair required within 6 months, or next availability, whichever is first, or DFS.
[6] Repair required immediately.

505-A.3 EXAMPLES

505-A.3.1 PURPOSE. This section provides examples which illustrate the process and rationale used to determine whether fasteners in a joint are acceptable for continued service.

505-A.3.2 OVERVIEW OF EXAMPLES. Each example provides a description of the joint, the conditions found, an evaluation of the conditions found, and the results of this evaluation. Following each list, an Inspection Checklist (see Image 1) is provided which shows proper documentation of the inspection.

In the examples presented, the data entries are typed on the Inspection Checklist. Checklists data filled in during an actual inspection should be handwritten.

505-A.3.2.1 Example 1. Description of Joint:

Force draft blower throttle valve inlet flange connected to 1200-psi desuperheated steam system. Conditions Found:

No indication of recent leakage from the joint.

There are no missing fasteners, none are heavily corroded, stud threads are fully engaged with nuts, and nuts are tight against the flange face.

Measured flange thickness - 2.12 inches.

Pipe size - could not be measured, however table 505-A-3 lists pipe outside diameter as 4.5 inches.

Measured stud diameter - 1-1/4 inches.

All eight studs on the joint are material grade B7.

One nut on each of three studs is grade 4, the rest are grade 2H. Evaluation:

1. From table 505-A-3, eight studs with 1-1/4 inch diameter are required.

2. From table 505-A-1, B7 or B16 are acceptable stud material grades and H, 2H, 4 or 7 is an acceptable nut material grades. All installed studs and nuts are one of the acceptable material grades, and all other conditions are acceptable. Results:

The joint is Category 1 - Acceptable.

INSPECTION CHECKLIST (Example 1)[1]

1. Application_1200 psi desuperheatesd steam__________
2. Indication of Recent Joint Leakage Yes___ No__✔__
3. Flange Thickness (per Figure A-2) __2.12"
4. Class of Flange (per Table A-3) __Class 1500
5. Pipe Outside Diameter (verify per Table A-3 using flange thickness) unknown (4.5" per Table A-30)
6. Nominal Pipe Size (per Table A-3) ____4"
7. Number of required Bolts or Studs (per Table A-3) ____8
8. Required Bolt or Stud Diameter (per Table A-3) __1-1/4___inch
9. Acceptable Bolt or Stud Grade (per Table A-1) __B7, B16
10. Acceptable Nut Grade (per Table A-1) __H, 2H, 4, 7
11. Inspection Results:

Joint Description/Location:							
Fastener Number[2]	Actual Material[3]		Stud or Bolt or Nut Conditions Acceptable				
	Stud or Bolt	Nut(s)	Correct Stud or Bolt Diameter	Fully Engaged Thread	Not Heavily Corroded	Not Missing	Tight Against Flange
1	B7	2H/2H	✔	✔	✔	✔	✔
2	B7	2H/2H	✔	✔	✔	✔	✔
3	B7	2H/2H	✔	✔	✔	✔	✔
4	B7	2H/4	✔	✔	✔	✔	✔
5	B7	2H/4	✔	✔	✔	✔	✔
6	B7	2H/4	✔	✔	✔	✔	✔
7	B7	2H/2H	✔	✔	✔	✔	✔
8	B7	2H/2H	✔	✔	✔	✔	✔
9							
10							
11							
12							

12. Per Acceptance Criteria, Circle one Acceptance Category:

Category 1 - Acceptable[4] Category 2 - Interim Acceptable[5] Category 3 - Unacceptable[6]

13. Inspected by: ________________________________ Date __________

14. Approved by: ________________________________ Date __________

[1] Applies only to installed fasteners in non-nuclear surface ship steam system bolted pipe joints.
[2] Fastener number is arbitrary, depending on local procedure (could start with No. 1 at 12 o'clock and proceed clockwise).
[3] Per markings on fasteners or per "Criteria for Identification of Unmarked Fasteners" if unmarked.
[4] Acceptable for continued service.
[5] Repair required within 6 months, or next availability, whichever is first, or DFS.
[6] Repair required immediately.

505-A.3.2.2 Example 2. Description of Joint:

Orifice flange for drain off 1200-psi desuperheated steam system Conditions Found:

No indication of recent leakage from the joint.

There are no missing fasteners, none are heavily corroded, stud threads are fully engaged with nuts, and nuts are tight against flange face.

Measured flange thickness - 0.88 inch.

Measured pipe diameter - 0.84 inch.

Measured stud diameter - 3/4 inch.

All of the studs are material grade B7, five of the nuts are grade 2H, and three are Monel grade 400. Evaluation:

1. From table 505-A-3, four studs are 3/4-inch diameter are required, which agrees with measured diameter. Also, from table 505-A-3, the nominal pipe size is 1/2 inch and the flange is Class 1500.

2. From table 505-A-1, B7 is an acceptable material grade for the four studs and 2H is an acceptable trade for five of the nuts. Three of the nuts are Monel grade 400, an interim acceptable material.

3. The discrepancies with this joint are the three nuts. Specifically, each nut is Monel 400, not an acceptable material grade for this service. However, Monel 400 is an interim acceptable grade for nuts in this service.

4. Because the only discrepancy is the interim acceptable material grade for the nuts, the joint can qualify as interim acceptable under part (2) of the Category 2 acceptance criteria.

   Justification: Editorial change as recommended by comment (120.01). Results:

The joint is Category 2 - Interim Acceptable.

INSPECTION CHECKLIST (Example 2)[1]

1. Application 1200 psi desuperheated steam
2. Indication of Recent Joint Leakage Yes___ No ✔
3. Flange Thickness (per Figure A-2) 0.88"
4. Class of Flange (per Table A-3) Class 1500
5. Pipe Outside Diameter (verify per Table A-3 using flange thickness) 0.84'
6. Nominal Pipe Size (per Table A-3) 1/2
7. Number of required Bolts or Studs (per Table A-3) 4
8. Required Bolt or Stud Diameter (per Table A-3) 3/4 inch
9. Acceptable Bolt or Stud Grade (per Table A-1) B7, B16
10. Acceptable Nut Grade (per Table A-1) H, 2H, 4, 7
11. Inspection Results:

Joint Description/Location:							
Fastener Number[2]	Actual Material[3]		Stud or Bolt or Nut Conditions Acceptable				
	Stud or Bolt	Nut(s)	Correct Stud or Bolt Diameter	Fully Engaged Thread	Not Heavily Corroded	Not Missing	Tight Against Flange
1	B7	2H/400	✔	✔	✔	✔	✔
2	B7	2H/400	✔	✔	✔	✔	✔
3	B7	2H/2H	✔	✔	✔	✔	✔
4	B7	2H/400	✔	✔	✔	✔	✔
5							
6							
7							
8							
9							
10							
11							
12							

12. Per Acceptance Criteria, Circle one Acceptance Category:

Category 1 - Acceptable[4] Category 2 - Interim Acceptable[5] Category 3 - Unacceptable[6]

13. Inspected by: ______________________________ Date __________

14. Approved by: ______________________________ Date __________

---

[1] Applies only to installed fasteners in non-nuclear surface ship steam system bolted pipe joints.
[2] Fastener number is arbitrary, depending on local procedure (could start with No. 1 at 12 o'clock and proceed clockwise).
[3] Per markings on fasteners or per "Criteria for Identification of Unmarked Fasteners" if unmarked.
[4] Acceptable for continued service.
[5] Repair required within 6 months, or next availability, whichever is first, or DFS.
[6] Repair required immediately.

Justification: Typographical error, comment (148.21)

505-A.3.2.3 Example 3. Description of Joint:

Orifice flange for drain off 1200-psi main steam system. Conditions Found:

No indication of recent leakage from the joint.

There are no missing fasteners; one stud is heavily corroded and the nut on one end of that stud is not tight against the flange face; all studs threads are fully engaged with nuts.

Measured flange thickness - 1.19 inches.

Measured pip diameter - 0.84 inch.

Measured stud diameter - three studs - 3/4 inch; one stud (heavily corroded stud) - 1/2 inch.

Three of the studs are material grade B16 and all the nuts are grade 4. The heavily corroded 1/2 inch stud is grade B7. Evaluation:

1. From table 505-A-1, four studs with 3/4-inch diameter are required. Consequently, the 1/2-inch-diameter stud is undersized. Also, from table 505-A-3, the nominal pipe size is 1/2 inch and the flange is Class 2500.

2. From table 505-A-1, B16 is an acceptable stud material grade and grade 4 or 7 nuts are acceptable. One stud is B7 material grade which is neither an acceptable nor interim acceptable grade. All four of the nuts are acceptable material grades.

3. This joint has one discrepant fastener, which is an undersized, heavily corroded stud of the wrong material grade. Also, one of the nuts on the stud is not tight against the flange.

4. From table 505-A-4, one discrepancy is allowed on a fastener assembly for this nominal pipe size and class. Therefore, the joint can qualify as interim acceptable under part (1) of the Category 2 acceptance criteria.

   Justification: Editorial change as recommended by comment (120.01). To indicate that stud of B7 material, heavily corroded stud with one nut not tight against the flange and the undersized stud are all the same stud, comment (148.22). Results:

The joint is Category 2 - Interim Acceptable.

INSPECTION CHECKLIST (Example 3)[1]

1. Application 1200 psi main steam
2. Indication of Recent Joint Leakage Yes___ No ✔
3. Flange Thickness (per Figure A-2) 1.19"
4. Class of Flange (per Table A-3) Class 2500
5. Pipe Outside Diameter (verify per Table A-3 using flange thickness) 0.84"
6. Nominal Pipe Size (per Table A-3) 1/2"
7. Number of required Bolts or Studs (per Table A-3) 4
8. Required Bolt or Stud Diameter (per Table A-3) 3/4 inch
9. Acceptable Bolt or Stud Grade (per Table A-1) B16
10. Acceptable Nut Grade (per Table A-1) 4 or 7
11. Inspection Results:

Joint Description/Location:							
Fastener Number[2]	Actual Material[3]		Stud or Bolt or Nut Conditions Acceptable				
	Stud or Bolt	Nut(s)	Correct Stud or Bolt Diameter	Fully Engaged Thread	Not Heavily Corroded	Not Missing	Tight Against Flange
1	B16	4/4	✔	✔	✔	✔	✔
2	B16	4/4	✔	✔	✔	✔	✔
3	B16	4/4	✔	✔	✔	✔	✔
4	B7	4/4	X	✔	X	✔	X
5							
6							
7							
8							
9							
10							
11							
12							

12. Per Acceptance Criteria, Circle one Acceptance Category:

Category 1 - Acceptable[4] Category 2 - Interim Acceptable[5] Category 3 - Unacceptable[6]

13. Inspected by: ______________________________ Date __________

14. Approved by: ______________________________ Date __________

1 Applies only to installed fasteners in non-nuclear surface ship steam system bolted pipe joints.
2 Fastener number is arbitrary, depending on local procedure (could start with No. 1 at 12 o'clock and proceed clockwise).
3 Per markings on fasteners or per "Criteria for Identification of Unmarked Fasteners" if unmarked.
4 Acceptable for continued service.
5 Repair required within 6 months, or next availability, whichever is first, or DFS.
6 Repair required immediately.

505-A.3.2.4 Example 4. Description of Joint:

Main air ejector first-stage steam inlet valve flange, supplied steam from 150 psi auxiliary steam system. The temperature of the 150 psi auxiliary steam system is higher than 550°F. Conditions Found:

No indication of recent leakage from the joint.

There are no missing fasteners; one of the studs is heavily corroded and has a nut on one end which is fully engaged, and all nuts are tight against the flange face.

Measured flange thickness - 0.50 inch.

Measured pipe diameter - 1.315 inches.

Measured stud diameter - 1/2 inch.

All four studs are material grade B7 and all the nuts are material grade 8. Evaluation:

1. From table 505-A-3, four studs with 1/2-inch diameter are required, which agrees with the number and measured diameter of studs installed. Also, from table 505-A-3, the nominal pipe size is 1 inch and the flange is Class 150.

2. From table 505-A-1, B7 or B16 is an acceptable stud material grade and H, 2H, 4 or 7 is an acceptable nut material grade. The studs installed is an acceptable though the nuts are neither acceptable nor interim acceptable material grades. Consequently, none of the fasteners in the joint qualify as acceptable or interim acceptable. Results:

The joint is Category 3 - Interim Unacceptable.

Justification: Clarified this example by stating that the steam temperature is greater than 550 degrees F, as recommended by comment (15.25). This is necessary because grade 8 nuts are interim acceptable for 150 psi auxiliary steam systems up to 550 degrees F.

INSPECTION CHECKLIST (Example 4)[1]

1. Application 150 psi auxiliary steam
2. Indication of Recent Joint Leakage Yes___ No ✔
3. Flange Thickness (per Figure A-2) 0.50"
4. Class of Flange (per Table A-3) Class 150
5. Pipe Outside Diameter (verify per Table A-3 using flange thickness) 1.315"
6. Nominal Pipe Size (per Table A-3) 1"
7. Number of required Bolts or Studs (per Table A-3) 4
8. Required Bolt/Stud Diameter (per Table A-3) 1/2 inch
9. Acceptable Bolt/Stud Grade (per Table A-1) B7, B16
10. Acceptable Nut Grade (per Table A-1) H, 2H, 4, 5, 7
11. Inspection Results:

Joint Description/Location:							
Fastener Number[2]	Actual Material[3]		Stud/Bolt/Nut Conditions Acceptable				
	Stud/Bolt	Nut(s)	Correct Stud/Bolt Diameter	Fully Engaged Thread	Not Heavily Corroded	Not Missing	Tight Against Flange
1	B7	8/8	✔	✔	✔	✔	✔
2	B7	8/8	✔	X	X	✔	✔
3	B7	8/8	✔	✔	✔	✔	✔
4	B7	8/8	✔	✔	✔	✔	✔
5							
6							
7							
8							
9							
10							
11							
12							

12. Per Acceptance Criteria, Circle one Acceptance Category:

Category 1 - Acceptable[4] Category 2 - Interim Acceptable[5] Category 3 - Unacceptable[6]

13. Inspected by: ______________________ Date __________

14. Approved by: ______________________ Date __________

[1] Applies only to installed fasteners in non-nuclear surface ship steam system bolted pipe joints.
[2] Fastener number is arbitrary, depending on local procedure (could start with No. 1 at 12 o'clock and proceed clockwise).
[3] Per markings on fasteners or per "Criteria for Identification of Unmarked Fasteners" if unmarked.
[4] Acceptable for continued service.
[5] Repair required within 6 months, or next availability, whichever is first, or DFS.
[6] Repair required immediately.

505-A.4 REFERENCES

1. MIL-STD-777E (SH), ″Schedule for Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships,″ dated February 7, 1986.

2. NAVSEA Report, ″Effect of Bolt Material Discrepancies on the Integrity of ANSI B16.5 Bolted Flange Connections Under External Moment Loads,″ prepared by MPR Associates, Inc. dated May 1993.

APPENDIX B

INDEX

Justification: Added missing title and column headings at the top of First Revision page Index-23, as an editorial change only. Change recommended by comment (53.19).

APPENDIX C

TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)

NOTE

Ships, training activities, supply points, depots, Naval Shipyards, and Supervisors of Shipbuilding are requested to arrange for the maximum practical use and evaluation of NAVSEA technical manuals. All errors, omissions, discrepancies, and suggestions for improvement to NAVSEA technical manuals shall be reported to the Commander, NAVSURFWARCENDIV, 4363 Missile Way, Port Hueneme, CA 93043-4307 on NAVSEA/ SPAWAR Technical Manual Deficiency/Evaluation Report (TMDER), NAVSEA Form 4160/1. To facilitate such reporting, print, complete, and mail NAVSEA Form 4160/1 below or submit TMDERS at web site
https://nsdsa2.phdnswc.navy.mil/tmder/tmder-generate.asp?lvl=1
All feedback comments shall be thoroughly investigated and originators will be advised of action resulting therefrom.

TMDER / MAILER